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Neolithic Surgeon

SUTUREGRAM

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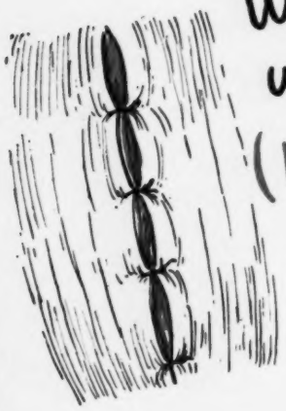


When tissues are sutured under tension

(1) Either gaping occurs between sutures if tension is not great or —

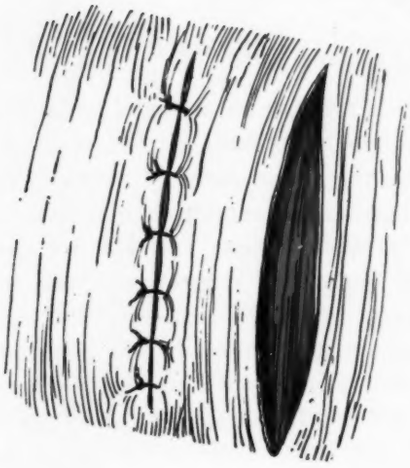
(2) Some of the sutures stretch between separated wound edges.

In both cases necrosis occurs where sutures hold tissues. Edges separate although sutures remain fully tied.

SUTUREGRAM

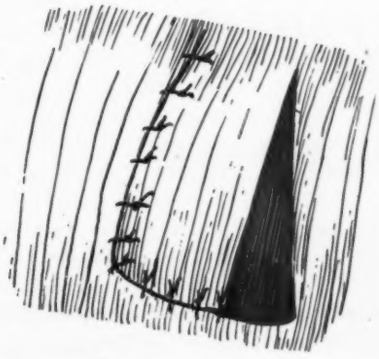
NUMBER FOURTEEN (CONTINUED)

Prevention of Separation



(a) Make release incisions on one or both sides or

(b) Swing flap of fascia



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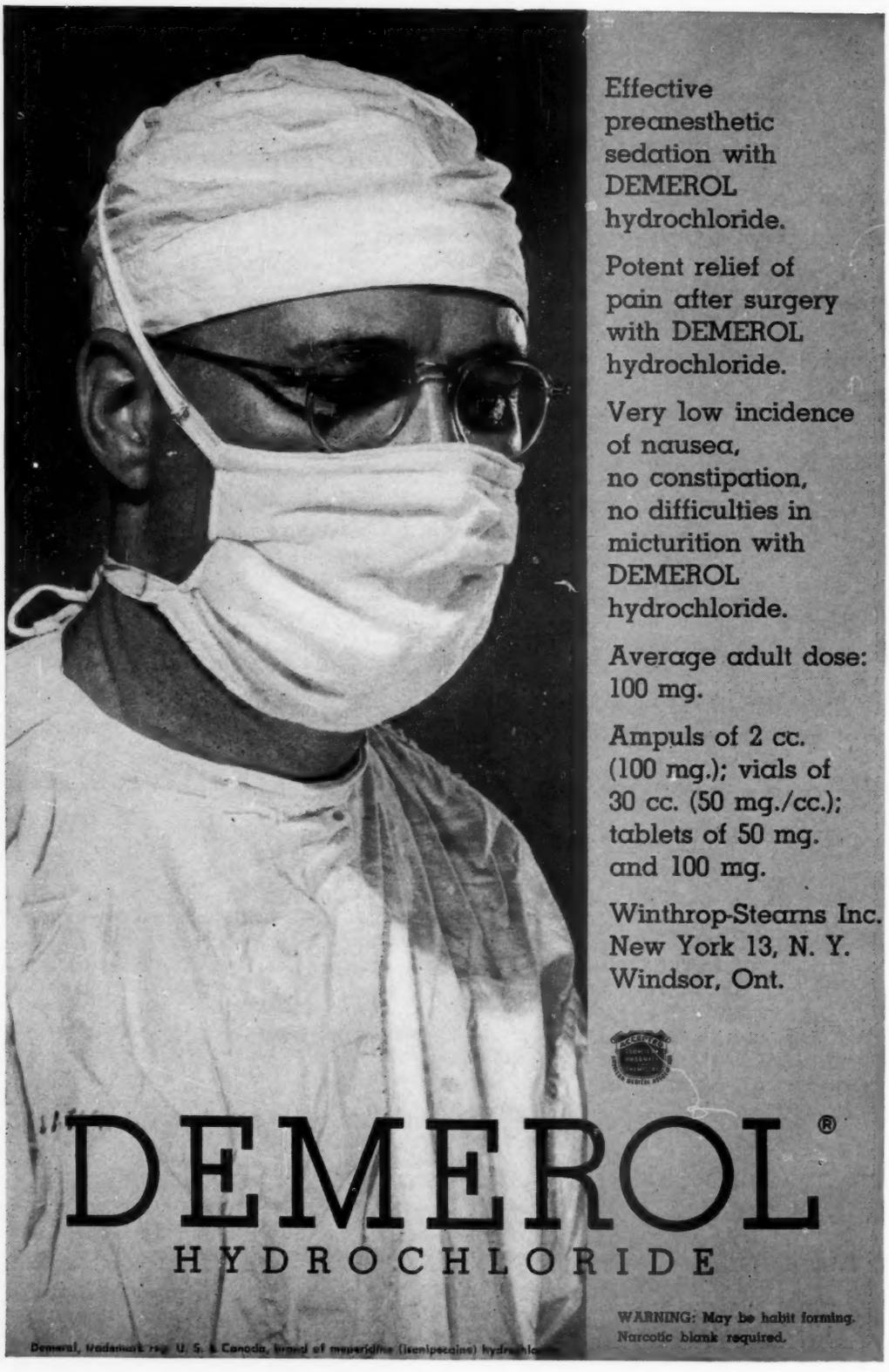

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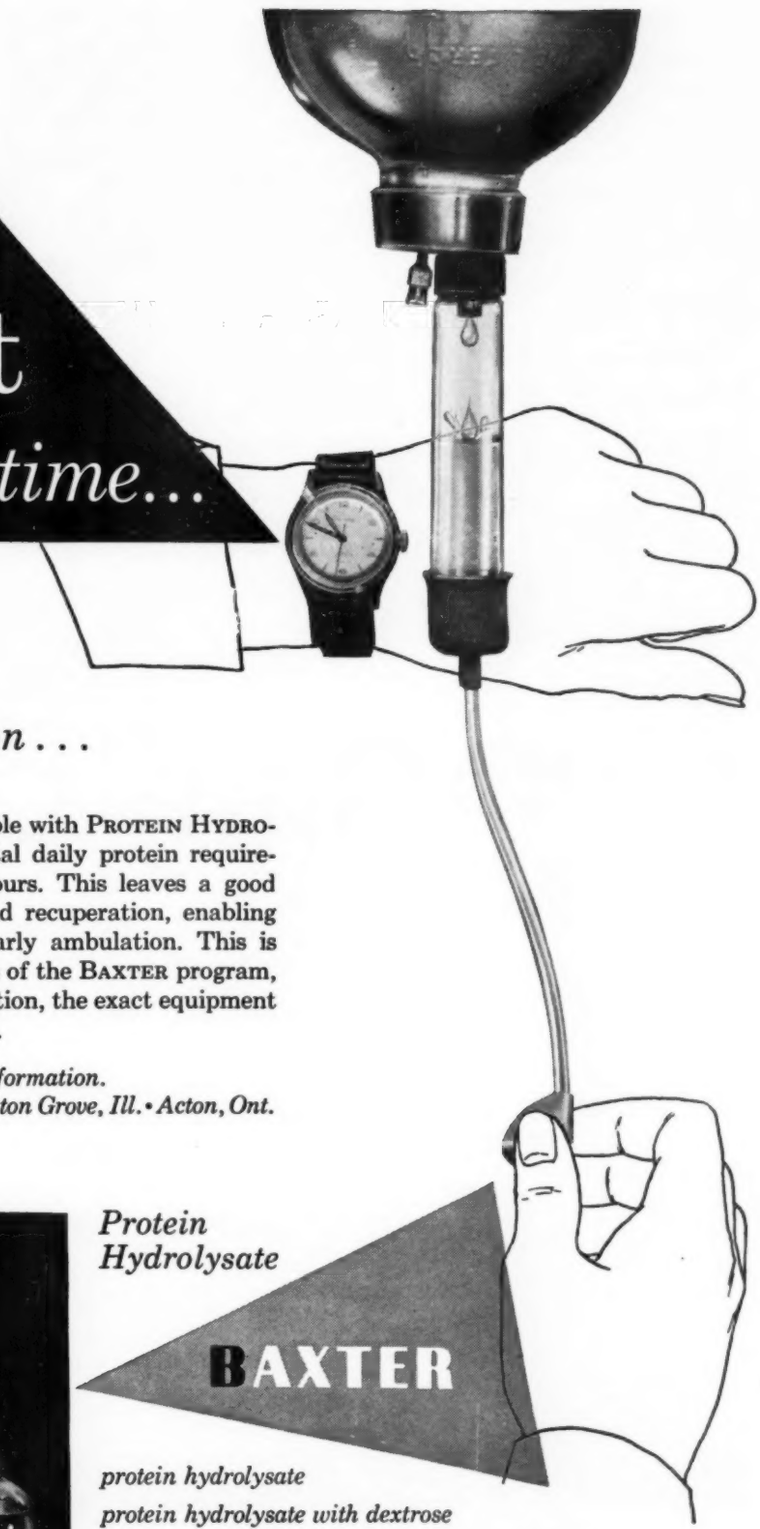

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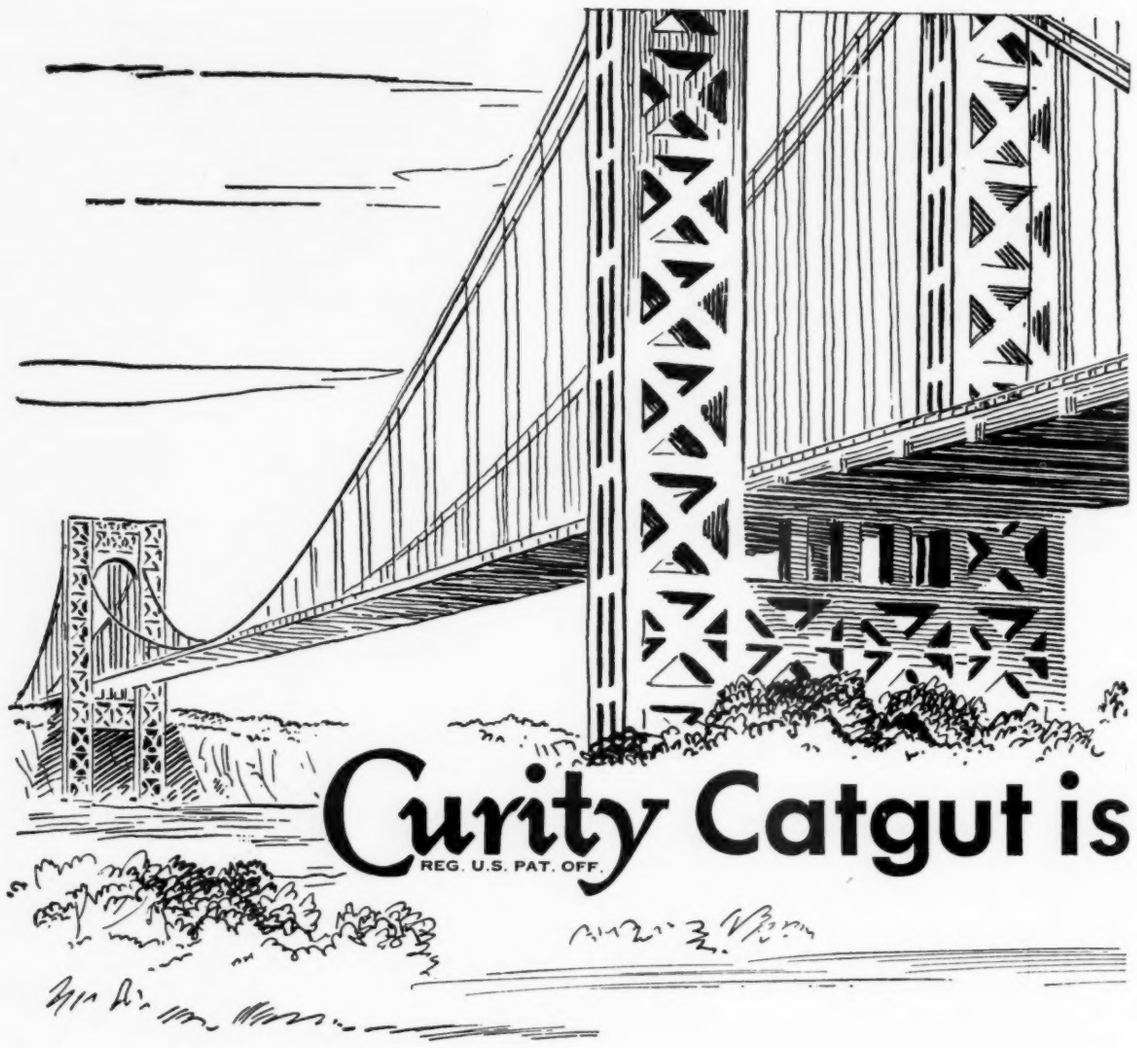

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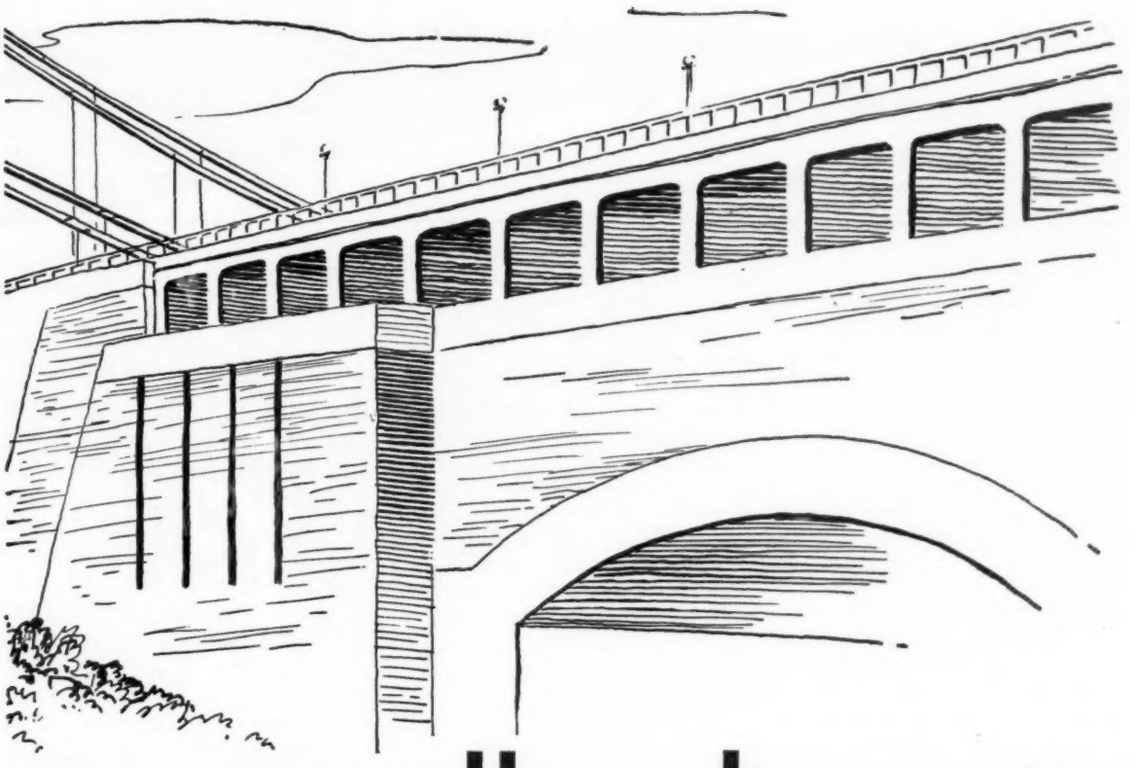

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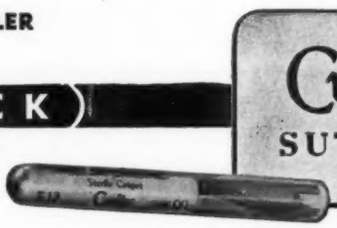

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* * *

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* * *

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* * *

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*Helfrick, J. Rembrandt: Amer. Jour. Surgery 70-1:131-132, October, 1945

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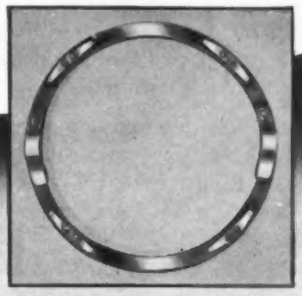

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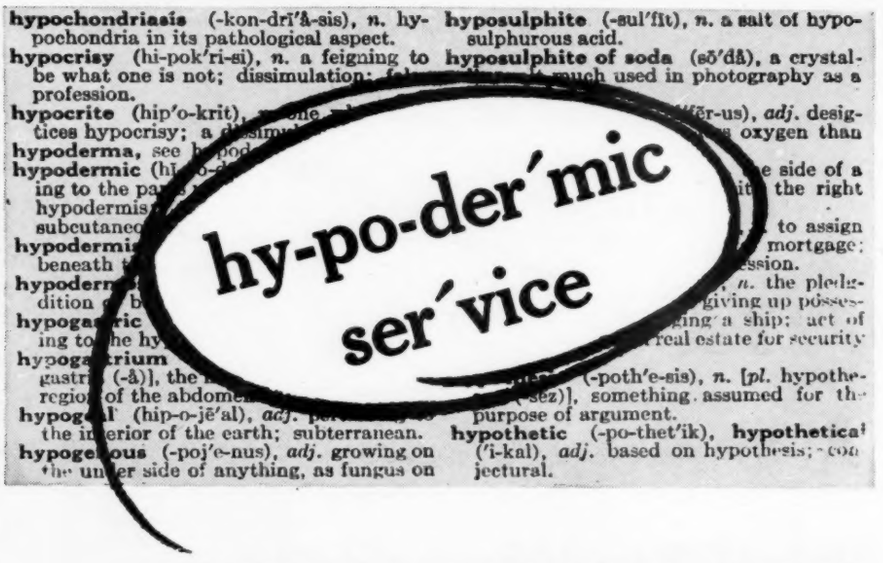

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Outside the Ivory Tower

THE "Ciba Collection of Medical Illustrations" by Frank H. Netter, M.D. is one of the most unique and worth while volumes it has been our privilege to own and enjoy. The illustrations are a compilation of pathologic and anatomic paintings. These are the result of about ten years' work by Dr. Netter, and were distributed to the medical profession as separate sets of plates in portfolio form. Of course, thousands of physicians are familiar with this work and it was due to the many requests for extra copies that prompted the Ciba people to bring out this volume.

In this country color reproductions are expensive. It has been every medical editor's prayer that he will, one day, be able to publish colored illustrations along with the text. To date, this has been practically impossible.

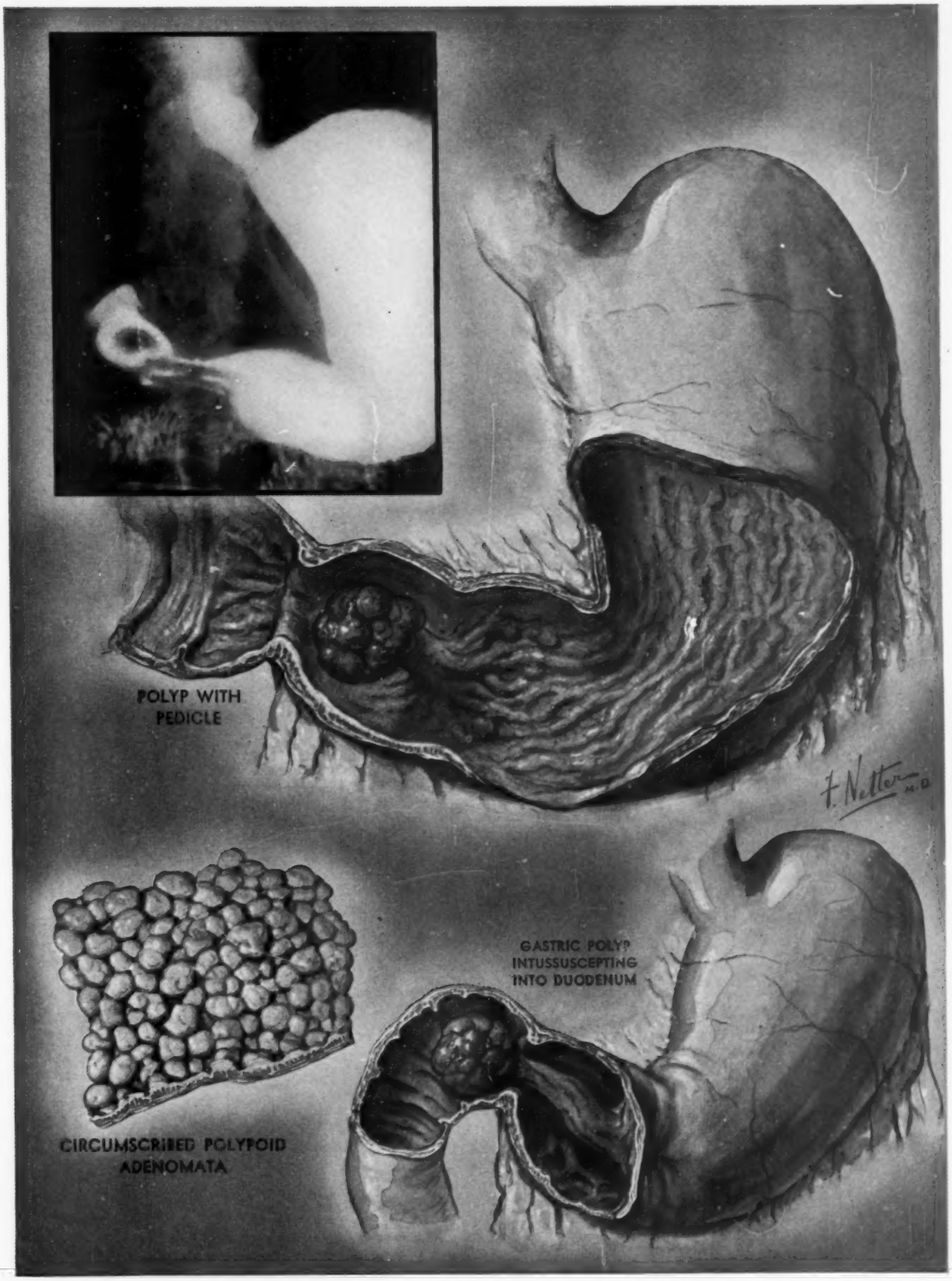
Dr. Joseph Felsen wrote the Foreword. Part of his Foreword makes an adequate and truthful review. He wrote, "This work has been admirably conceived and executed, particularly with regard to the details exhibited in the excellent art work by Dr. Netter. The explanatory legends by Drs. Buckstein, DeBakey, Geschickter, MacBrayer, Ritter, Rubin, and Vest are, for the most part, concise, accurate and informative. These legends are intended for the pathologist, physician, or surgeon who appreciates such material in condensed form, in contrast to the detailed information available in monographs or textbooks. The method of presentation in the Ciba collection is an excellent one both for the undergraduate student and the busy practitioner."

The contents cover four sections: (1) Lungs and Chest; (2) Gastrointestinal Tract; (3) Male Reproductive Organs and Male and Female Mammary Glands and (4) Heart and Aorta. In all there are 191 plates. The Ciba Pharmaceutical Products, Inc. plan that when enough additional plates have been completed another volume will be issued. Facing this page are illustrations from the book. It is worth owning and an ideal gift to a medical student, intern, resident or fellow practitioner.

"COLLATERAL Circulation (Anatomical Aspects)" was written by Daniel P. Quiring, PH.D., Head of the Anatomy Division, Cleveland Clinic Foundation and Associate Professor of Biology, Western Reserve University. There are 61 illustrations, 46 in color. This work presents the anatomic aspects of collateral circulation. A discussion of many factors is also included which must be considered in determining the success or failure of a collateral network. It is valuable to anatomists, medical students, cardiologists and surgeons. The publishers: Lea & Febiger; the price $5.00. The work is 469 pages long and the biographies are arranged alphabetically. We suggest that in future editions an index be included. The author had done a creditable piece of work, and we heartily recommend this book to all who are interested in the lives of those who, as master surgeons, have made present day surgery possible.

DR. RICHARD A. LEONARDO sent us an autographed copy of his latest work, "Lives of Master Surgeons." Our library is heavy with autographed works. If they are the run-of-the-mill stuff, we write and thank the author, then read a few pages here and there and forget the entire incident. Once a friend of ours wrote an excellent textbook. The publishers did not send us a copy for review so we bought one and wrote a favorable blurb. When the author forwards us a personal copy and we find it good, we sit down and pass on the good word via the written page; and Leonardo's book is good. This volume (we read) is a separate entity (it may be considered as Volume 2 of the author's History of Surgery series), and describes the paths followed in the quest for greater surgical knowledge. Dr. Leonardo includes the more important, internationally famous surgeons, plus some of the leading American surgeons. The author says that some important men have been unintentionally omitted, but if any of the readers should know of a master surgeon who merits inclusion, he should so inform the author.

(continued on page 17)



BENIGN TUMORS OF THE STOMACH

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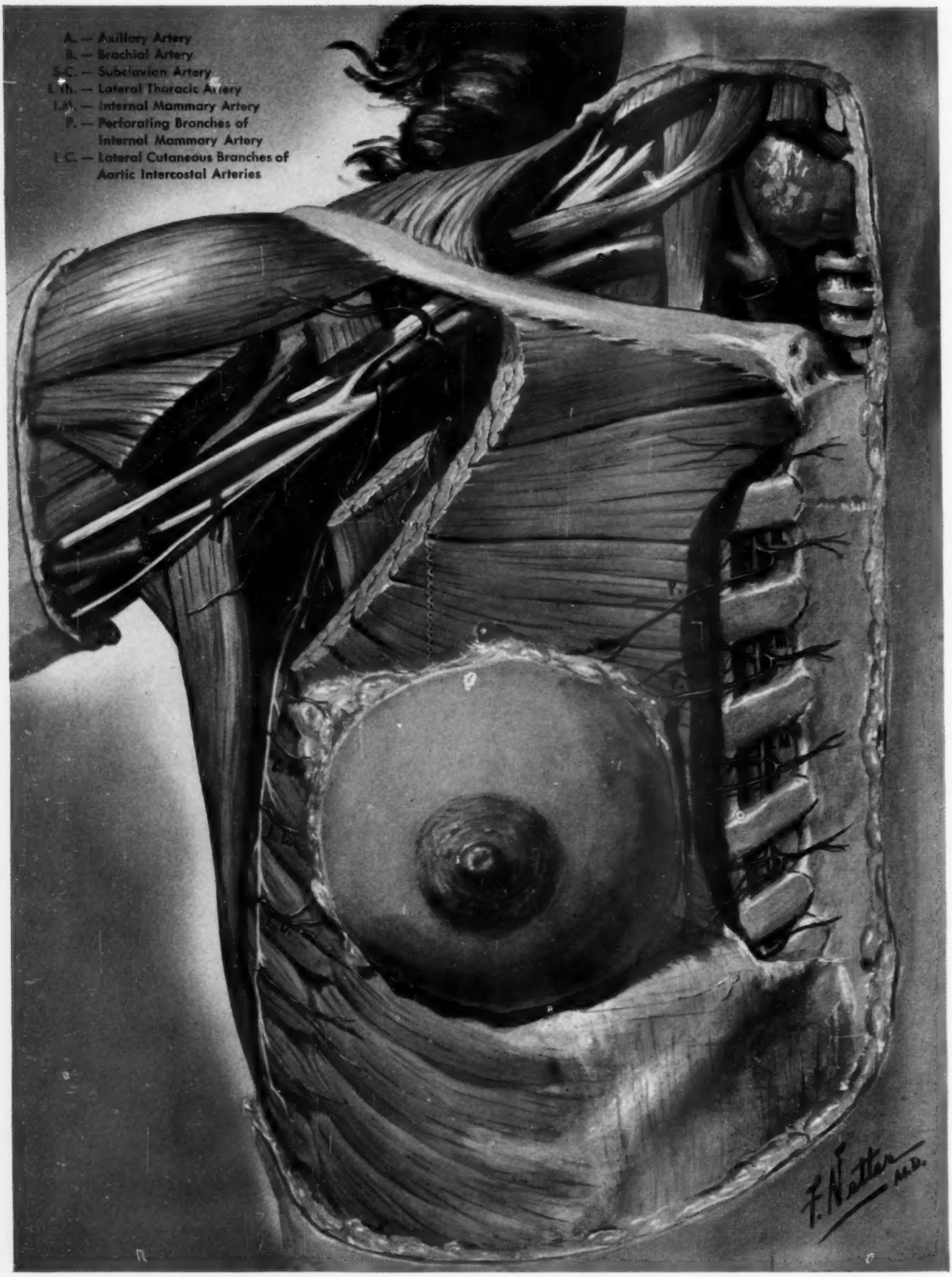
A. — Axillary Artery
B. — Brachial Artery
S.C. — Subclavian Artery
L.Th. — Lateral Thoracic Artery
I.M. — Internal Mammary Artery
P. — Perforating Branches of Internal Mammary Artery
L.C. — Lateral Cutaneous Branches of Aortic Intercostal Arteries
F. Netter M.D.

BLOOD SUPPLY OF THE BREAST

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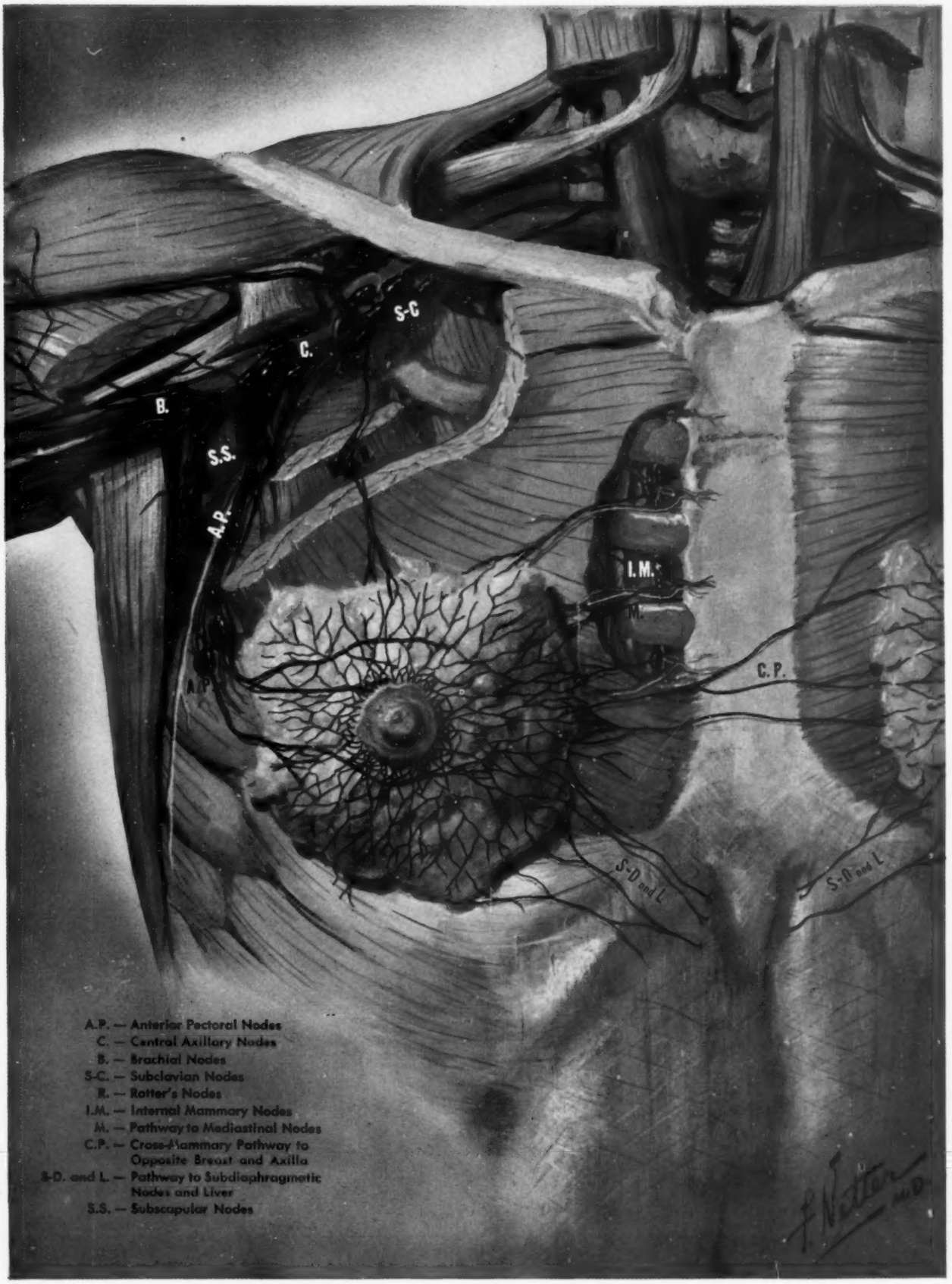

LYMPHATIC DRAINAGE OF THE BREAST

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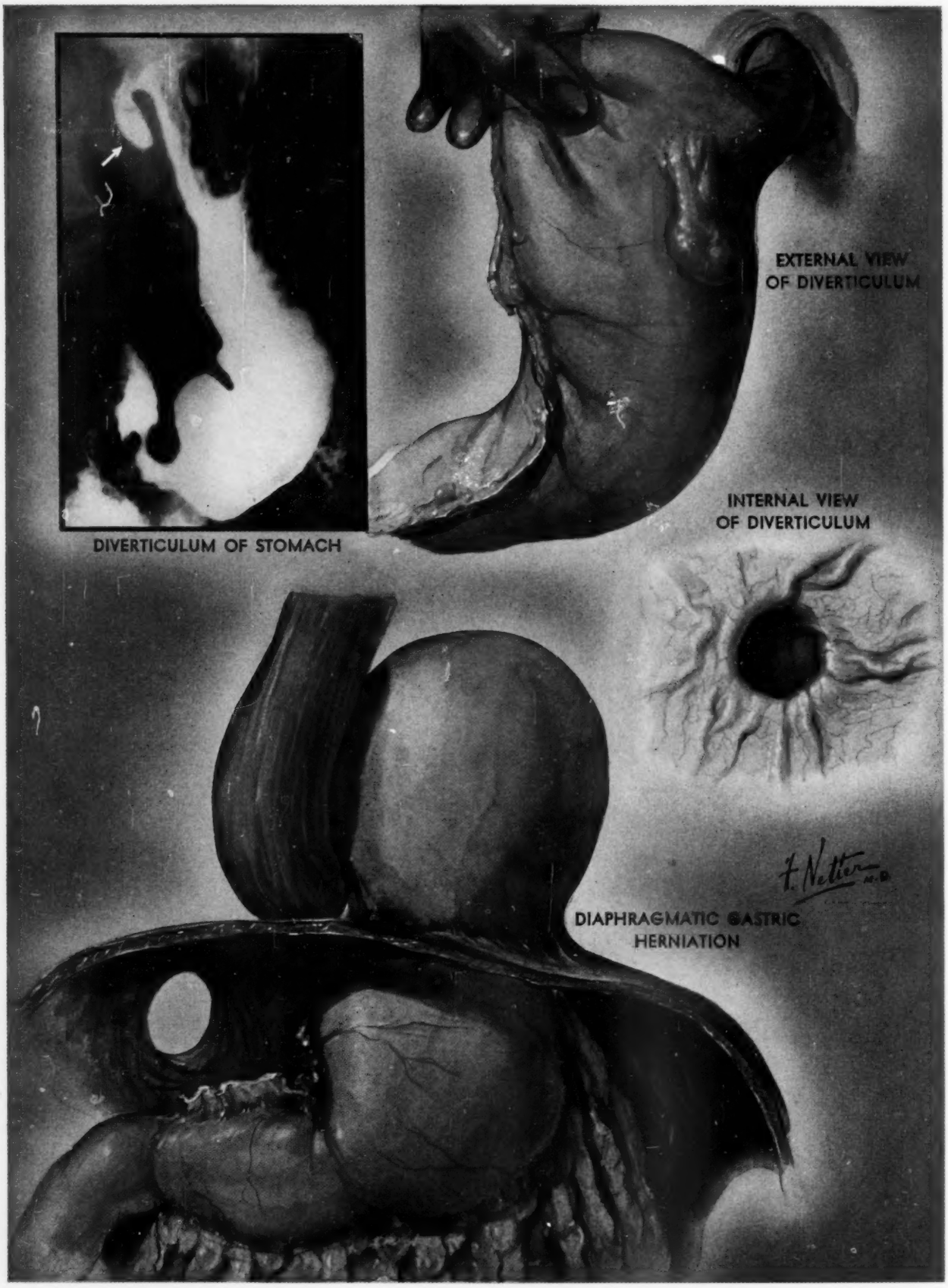

DIVERTICULUM OF THE STOMACH

Reproduction of the illustration from page 95 of
"THE CIBA COLLECTION OF MEDICAL ILLUSTRATIONS"

Outside the Ivory Tower

(*continued from page 16*)

AN outstanding publishing feat of the year is the second edition of Campbell's "Operative Orthopedics." It is edited by J. S. Speed, M.D. and the Associate Editor is Hugh Smith, M.D. of Memphis, Tenn. The authors of various chapters are H. B. Boyd, M.D., J. F. Hamilton, M.D., A. J. Ingram, M.D., Francis Murphy, M.D., D. B. Slocum, M.D., Hugh Smith, M.D., M. N. Smith-Petersen, M.D., J. S. Speed, M.D., M. J. Stewart, M.D. and T. L. Waring. All except Drs. Murphy, Slocum and Smith-Petersen are members of the Staff of Campbell Clinic and faculty of the University of Tennessee. The work is in two volumes and contains 1,643 pages, an author's index and subject index (43 pages), and at the conclusion of each chapter are ample references. There are 1,141 illustrations, including two color plates. In the preface we read, "The primary purpose of this book is to impart pertinent orthopedic information in the light of our present knowledge, by compiling previous and contemporary operative technics infiltrated with personal suggestions, variations, and our own original technics." The authors' live up to this blue print. Any surgeon working in this field, and all orthopedic men, will find this work valuable. Every young man working toward his Board examination in orthopedics should possess these volumes, even though he must sacrifice to do so. The cost is $30 and it is published by C. V. Mosby.

WHEN a physician has finished his day's work and wishes for something different but absorbing, we recommend he take up Maurice Bear Gordon's "Aesculapius Comes to the Colonies." It is the story of the early days of medicine in the thirteen original colonies. We merely started to glance through it. The hour was late and we had an early morning appointment but we could not put it down. We found it better reading than most popular magazine articles and far more satisfying than the great majority of modern novels. Dr. Gordon must have spent many long hours in gathering his facts and writing this book (560 pages, illustrated, indexed). His style is engaging. Anyone interested in the medical history of our country will want to own a copy. It is just the gift for a medical confreré and is different from most historical works. Ventor Publishers Incorporated put out this book for $10.

ANOTHER large (915 pages) book of distinction is "Hematology" by Cyrus C. Sturgis, M.D., Professor of Internal Medicine, University of Michigan Medical School. Dr. Sturgis holds other important positions, as the well informed know. Therefore, if one desires or needs a work on hematology, we seriously recommend this book. The field is covered in detail. There are illustrations, some in color, and the bibliography and index are thoroughly and well done. We believe that every physician who is engaged in general practice, surgery or internal medicine should own and become well acquainted with the contents. The cost is $12.50 and Charles C. Thomas is the publisher.

WALTER C. ALVAREZ'S "An Introduction to Gastro-Enterology," is a tome of 903 pages. It is a fourth edition, revised and enlarged, published by Paul B. Hoeber, Inc., and the price is $12.50 (and worth every penny of it). In reality, this work is the fourth edition of "The Mechanics of the Digestive Tract." The first edition was brought out in 1922. Walter Alvarez needs no introduction to American physicians. Many, many years ago he forsook a large private practice to go with the Mayo Clinic because he wanted to do research. This is an outstanding work by an outstanding scientist. His style is delightful; he is never dull; and one can believe what one reads. Alvarez's book should be on the shelves of surgeons and internists as well as others in the various medical fields.

WE must close this book session, but before we sign off we have to mention two worth while short works that are often disregarded, because they are short, for the more ponderous tomes. They are "Post-traumatic Epilepsy" by A. Earl Walker, M.D. It contains 90 pages, 28 illustrations, 80 references and 6 tables. Charles Thomas is the publisher, and the price is $2.75.

"Nursing Care of Neurosurgical Patients" by Roland M. Klemme M.D. containing 142 pages, 62 figures and 1 plate in color, is also published by Charles C. Thomas and costs $3.00. Any one practicing neurosurgery would do well to present all nurses attending his patients with a copy of this book.

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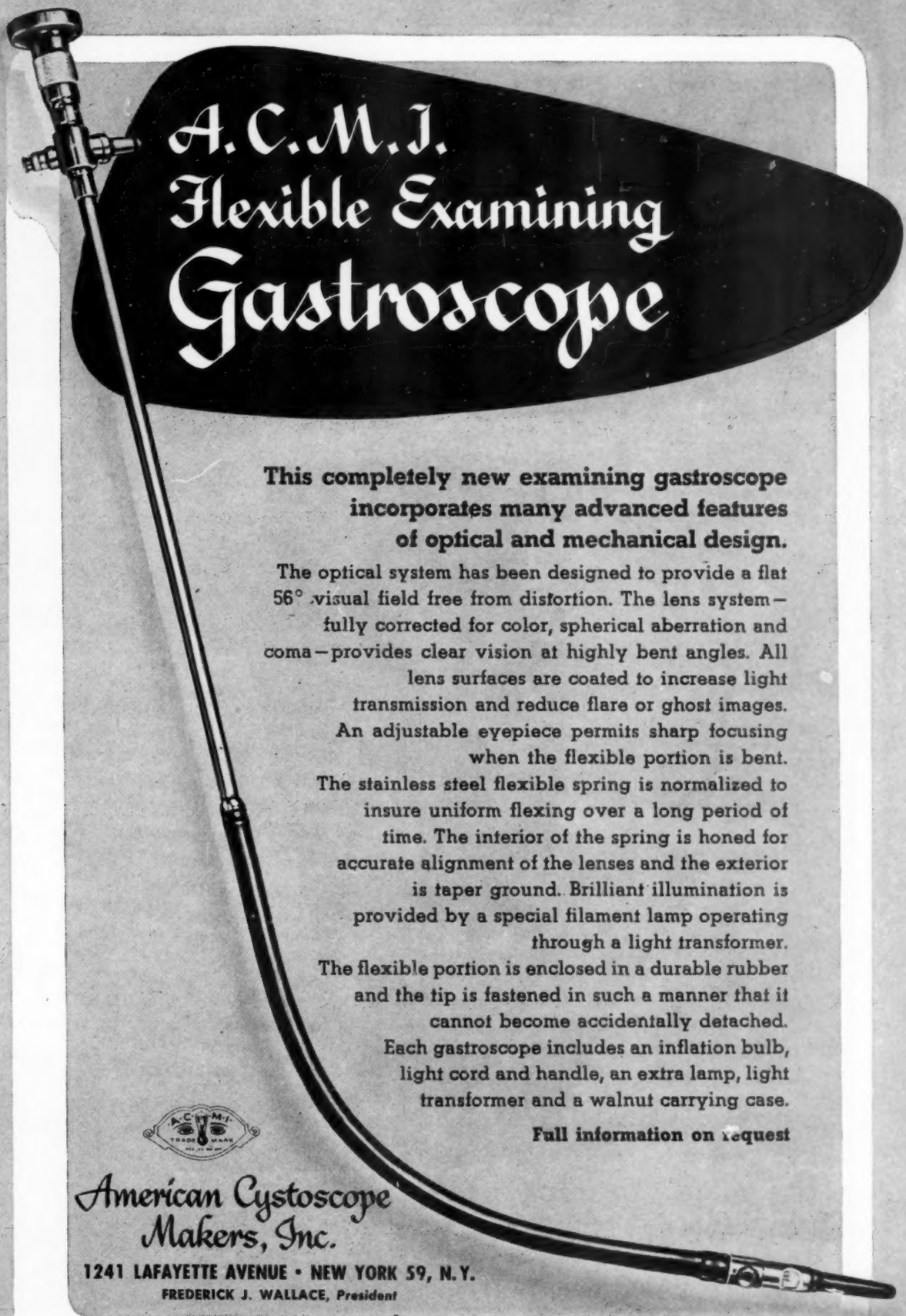

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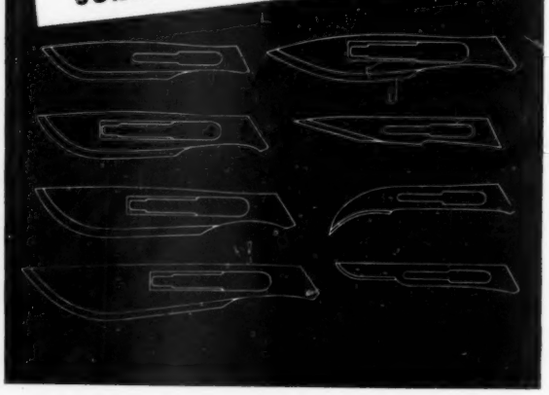

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Pregnancy
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Pylorospasm
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Colitis
Biliary dyskinesia

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To combat stimulation of ephedrine alone, etc.

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Central Nervous System
Paralysis agitans
Chorea
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Mania

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Traumatic
Tetanus
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CONFIRMS IMPORTANCE OF

Morning Meal

A study* recently concluded at the Departments of Physiology and Nutrition of the college of medicine at a distinguished university established that the value of an adequate breakfast, as recommended by nutrition authorities, is definitely reflected in maximum work output and mental acuity during the pre-noon hour.

It also demonstrated that the long continued omission of breakfast detrimentally affects maximum work output, simple and choice reaction time, and neuromuscular tremor.

Under adequately controlled conditions data were collected on the effects of four different breakfast habits on the maximum work output, mental acuity, and neuromuscular tremor of six young women ranging from 22 to 27 years in age. The breakfast habits investigated constituted habituation to an 800 calorie breakfast, effects of which were considered the critical standard, to no breakfast, to coffee only (1 cup of coffee, 1 ounce of cream, no sugar), and to a 400 calorie breakfast.

*Reprint of the study referred to will be sent on request.

From the data gathered the following conclusions were reached:

1. When "no breakfast" was the morning habit, maximum work output showed a significant *decrease*, while a notable *increase* resulted in simple and choice reaction time and in tremor magnitude.
2. Habituation to coffee only showed a similar *decrease* in maximum work output, with corresponding *increase* in reaction time and in tremor magnitude.
3. When habituation to the 400 calorie breakfast was accomplished after the "coffee only" period, a significant *increase* over the findings in the "coffee only" period in maximum work output resulted and both simple and choice reaction time as well as muscle tremor magnitude showed a noteworthy *decrease*.

The authors point out that no direct comparison could be made of the physiologic responses during the 400 calorie and 800 calorie breakfast periods, because the breakfast period of "coffee only" occurred between the 800 calorie and 400 calorie periods.

This controlled investigation now provides experimentally established support for the widely advanced admonition "Eat an Adequate Breakfast." For, though the authors do not draw this conclusion, it may well be reasoned inversely that maximum work output should be increased, and mental acuity improved, when faulty breakfast habits are replaced by the eating of an adequate morning meal.

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1. Less interference with healing through minimized foreign body reaction.

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***To illustrate this comparison, small laboratory trays are used. In commercial production, surface-chromicizing is done under tension. Both processes are performed in large vats.**

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Fifty-eighth Year of Publication

VOL. LXXVIII JULY, 1949 NUMBER ONE

Editorial

A SIMPLE QUESTIONNAIRE FOR THE TAKING OF HISTORIES IN CASES OF CANCER

THE taking of medical histories in hospitals and clinics is a duty usually assigned to junior members of the house staff and constitutes a part of their progressive post-graduate hospital training. Under certain circumstances this task may even be relegated to a medical secretary. These observations apply to general hospitals and clinics as well as to the more highly specialized institutes. The present report is concerned solely with cancer hospitals and tumor clinics.

In the course of his post-graduate hospital training the intern, resident or fellow probably does not remain long in a position where his duties include the taking of histories. As he reaches the senior positions on the house staff this traditionally somewhat onerous task is usually passed on down to successive junior members of the house staff. The result is that clinical histories in cancer cases, as they accumulate over a period of years, will have been taken by a succession of post-graduate trainees at a time when they are just beginning their hospital experience. The junior house officer, therefore, can hardly be expected to exercise reasonably good discrimination or to have attained sufficient insight regarding the type of questions which are essential in cancer cases. At any rate, without some specific directives the clinical records will hardly be complete or uniformly arranged. Although in some of the cases the histories may be excellent, in others the information will be so meager or so confused as to vitiate the over-all value of the greater mass of recorded data.

In highly specialized institutions such as cancer hospitals or tumor clinics one solution to the problem of the clinical history of the present illness would be to provide a set of instructions in the form of a questionnaire which would always be before the intern when he is actually taking the history. It seems reasonable to make such a questionnaire simple and concise so that even though it might not include all the details which must be recorded in a given case, it would provide a logical sequence of questions which would fully bring out in chronologic order the more important features in the history of the present illness and suggest the directions in which further inquiries might be made.

The following is a questionnaire which, if consistently and routinely employed, would tend to bring out the more significant points in a cancer history, many of which might otherwise be omitted. It is to be noted that all questions begin with and often include the specific interrogations, "when," "what" and "how."

After recording the family history and past medical history according to the usual routine, use the following questions for the present illness:

1. WHEN did you first notice anything wrong or abnormal in connection with your present complaint?

   If the patient gives an indefinite answer such as "about 3 months," recheck by asking the exact month. Record the exact month and year in the history.

2. WHAT SYMPTOM or difficulty did you notice *first* and what other symptoms followed and when?

   It is important to ascertain the exact first symptom. Some discretion may be used in recording the character and order of symptoms. Some are obviously entirely irrelevant.

   The following are the most significant symptoms (not necessarily the only ones) in the various anatomic forms of cancer. Their presence or absence should always be recorded.

   Skin and subcutaneous tissues: The lesion itself—ulcer—swelling.

   Mouth: The lesion itself—pain—cervical metastasis.

   Nasopharynx: Cervical metastasis—unilateral deafness or tinnitus.

   Oral and hypopharynx and extrinsic larynx: Dysphagia—cervical metastasis.

   Intrinsic larynx (vocal cords): Hoarseness.

   Esophagus: Dysphagia.

   Lung: Cough—hemoptysis—pain.

   Breast: Tumor mass—deformity—nipple bleeding.

   Stomach and small intestine: Indigestion—anorexia—vomiting—weight loss.

   G. U. system: Hematuria—dysuria—frequency.

   Gyn. viscera: Bleeding—discharge—pelvic pain.

   Large intestine and rectum: Change of bowel habit—bleeding.

   Leukemia and other blood dyscrasias: Fatiguability—bleeding tendency.

3. WHAT DID YOU FIRST THINK caused your trouble?

   The patients' opinion as to the cause of the growth is always of interest even though illogical.

4. WHEN AND HOW LONG AFTER the first symptom DID YOU CONSULT YOUR DOCTOR OR DENTIST? (Include cultists and irregular practitioners.)

   Always record the names and addresses of all doctors or dentists consulted. If only the last name and the street address (without the number) can be obtained, that information is nevertheless of value.

5. WHAT EXAMINATION did the doctor make? Did he make a rectal or vaginal examination? Did he use an endoscope or throat mirror? Did he take a specimen for examination or make a blood test? What treatment did he give or prescribe for you?

   It is essential to record the method of examination and subsequent management of a cancer case in order to fix responsibility for delay in diagnosis and treatment.

6. WHAT ADVICE did the doctor or dentist give you in regard to the necessity for further examination either by himself or by some other doctor? Did he tell you the name of your disease?

   The attitude of the first physician or dentist consulted in regard to advice and treatment is an excellent indication of their tentative diagnoses.

7. WHAT DID YOU DO in carrying out the doctor's advice?

   Continue interrogating the patient in regard to subsequent doctors consulted, treatment, operations, etc.

8. WHO finally REFERRED YOU to this Hospital or clinic and when was this advice first given?

   Attempts should be made to obtain accurate and specific information as to the name and address of the referring doctor or clinic. These parties often have biopsy slides, records of treatment, and furthermore expect to be informed of the patient's admission and progress under treatment.

Under Question 2, it should be noted that specific symptoms are listed in the order of their importance and would apply particularly to each of the major anatomic sites in which cancer is likely to occur. These symptoms are of such importance that they should be recorded both when

present and when absent. This list was obtained by checking with a number of surgeons and internists, each of whom had had many years of experience in one or another anatomic form of cancer. Each was asked to name the three most important symptoms in the order of their significance in a particular clinical field. It is to be noted that in certain diseases such as cancer of the intrinsic larynx and esophagus, a single symptom (hoarseness and dysphagia, respectively) stands out as being so constant and unique that no other symptoms need be listed under this particular heading.

In the Memorial Hospital this questionnaire has been found so useful that it is printed on the reverse side of the clinical history sheet so that it may be before the questioner at all times when taking and recording histories.

HAYES MARTIN, M.D.

Original Articles

VAGOTOMY AND THE ANATOMIC VARIATIONS IN THE VAGUS NERVE*

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THE recent extensive trial of vagotomy in the surgical therapy of peptic ulcer and the conflicting findings resulting from anatomic studies of vagus nerve distributions stimulated the present study. The investigation was undertaken with the purpose of determining whether the anatomic variations in the configuation of the vagus nerves between the levels of the bifurcation of the trachea and the incisura of the stomach (1) could be separated into definite patterns, (2) would disclose at what level within these limits the vagal trunks might be fewest and most readily isolated for surgical division, and (3) would reveal what anatomic variations might make difficult the transection of all vagal fibers at such a level. The studies of Bradley and his associates[1,2] and of Miller and Davis[3] have led the former to conclude that vagus nerve division is feasible through a subdiaphragmatic approach, and the latter to decide that transthoracic supradiaphragmatic vagus interruption is most desirable. The diametrically opposing views expressed in these simultaneous publications lent impetus to this study.

The material used for the study consisted of a random group of fifty well embalmed adult white and negro, male and female cadavers supplied by the Department of Anatomy of the School of Medicine of the University of Pennsylvania. After a preliminary trial of fresh material it was concluded that the use of well fixed material would be preferable to augment the accuracy of the identification and tracing of the finer branches of the vagi and the determination of the relationship of the vagal trunks to the esophagus and upper stomach. The vagi were identified at the level of the bifurcation of the trachea and traced caudad as far as the incisura of the stomach, all macroscopic branches on the esophagus and upper stomach being traced out as far as their identities permitted. Following each dissection, scale diagrams were drawn of the configuration of the vagi. The resulting diagrams were then arranged into groups of increasing complexity of arrangement of the vagal trunks. A number of diagrams have been selected and included herewith to illustrate the various representative patterns found.

It was apparent from these studies that the configurations of the vagi on the esophagus were sufficiently variable not to permit classification into patterns, but that the number and complexity of anterior and posterior gastric nerves at the level of the esophageal hiatus seemed to permit such classification into six groups of increasing complexity. (Table 1.) The distribution of the vagi showed the greatest degree of uniformity on the stomach.

Since the experimental work of Pavlov[4] it has been apparent that the vagus nerves are an indispensable connection between the brain and the stomach for the psychic phase of gastric secretion. This relation-

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ship has been supported by the experimental production of increased gastric peristalsis and secretion by hypothalamic stimulation and the abolition of these findings by section of the vagi.[5] In 1929 Hartzell[6] reported a marked decrease in gastric free and total acid secretion following complete transthoracic vagotomies in dogs. In studies of gastric pouch secretions in the dog after insulin injection Jemerin, Hollander and Weinstein[7] found good secretory responses in pouches with partial and almost intact vagus innervations and no responses in pouches with almost no vagus innervation. The secretions of total isolated dog stomach pouches with intact vagus and vascular supply showed a marked reduction in volume and acidity after vagus interruption.[8] Beaver and Mann[9] in 1931 and Haskins and Hooker[10] in 1947 reported a reduced incidence of peptic ulceration in Mann-Williamson dogs prepared with preliminary vagotomy.

The surgical approach to the vagus nerves is not a new procedure although the consistent performance of complete vagotomy and the elaboration of the physiologic rationale for the procedure are more recent developments. The early surgical attempts at vagotomy were directed largely toward the relief of tabetic gastric crises and various gastric disorders, many of which were without organic disturbances. Varying approaches and degrees of success were reported by Exner and Schwarzmann,[11] Bircher,[12] Latarjet,[13,14] Stierlin,[15] Steinthal,[16] Schiassi[17] and Pieri.[18] McCrea's review[19] in 1926 concluded that unilateral vagotomy is without influence on gastric function and that bilateral vagotomy yielded only delayed initial emptying of the stomach and abolition of the psychic phase of gastric secretion. In 1937 Barron and Curtis[20] obtained decreased duration and amplitude of gastric contractions following anterior vagotomy and in 1938 Winkelstein and Berg,[21] adding this procedure to subtotal gastric resection, obtained postoperative achlorhydria in twenty-six of thirty-four patients.

Countless investigators have demonstrated hypertonicity, hypermotility and hyperperistalsis in uncomplicated duodenal ulcer. In the opinion of Dragstedt,[8] the chief physiologic abnormality of the ulcer patient is the production of abnormally large quantities of gastric juice of normal acidity in the resting stomach particularly at night. In the gastrostomy patient Wolf and Wolff[22] found an augmented gastric secretion, motility and vascularity concomitant with resentment, anxiety and internal conflict. Since 1943 Dragstedt and his group[23–26] have reported a decrease in acidity and volume of night gastric secretions and diminished tonicity and motility following supradiaphragmatic vagotomy. Incomplete vagotomies apparently result in little alteration in free and total acidities.[27] These findings have been amply confirmed by Moore and associates,[28,29] Walters and associates,[2,30] Warren[31] and Grimson and his group.[32–35]

The foregoing experimental and clinical studies have indicated that gastric acid secretion is partly controlled by the vagi, and that only complete division of both vagi produces diminution in secretion.

According to the description in "Cunningham's Textbook of Anatomy,"[36] two nerve trunks pass from the inferior portion of each posterior pulmonary plexus to the corresponding side of the esophagus, and according to Gray's textbook,[38] one or more trunks are said to lie on each side. Mitchell[39] reported that the vagi were usually present as two to four main branches, with three being the common finding on the right and two on the left.

As the vagi in this series were traced cauded from the bronchi, it was noteworthy that the trunks rarely remained single on the esophagus for a distance of more than 5 cm. The usual finding was that of an anterior and a posterior complex, the anterior one being principally on the left side of the midline of the esophagus, particularly in the upper half of the dissected portion, and the posterior complex largely on the right side of the midline.

The anterior complex consisted of two to five nerve trunks which descended onto the left half of the esophagus from behind the left inferior pulmonary vein. These trunks split and regrouped according to no consistent pattern as the trunks passed caudad. Often one or two of the trunks ran caudad on the lateral or even posterolateral aspect of the esophagus before curving toward its anterior aspect in the lower half. One or two other trunks of the complex curved to the posterolateral aspect of the esophagus in the upper half to two-thirds of the dissected area, finally crossing the posterior aspect of the esophagus to join the posterior complex.

The trunks of the anterior complex usually fused into one or more anterior gastric nerves at or just above the level of the esophageal hiatus in the diaphragm.

The same general pattern of branching and anastomosing trunks characterized the posterior complex, some trunks of which often continued caudad on the right lateral and right anterolateral aspects of the esophagus. There were two to five trunks on the right side as on the left. The whole sweep of left-sided trunks anteriorward, and of right-sided trunks posteriorward, is the result of the 90 degree embryologic rotation of the stomach on its axis. (Fig. 1.)

From the branching and anastomosing trunks of the anterior and posterior complexes, finer branches arose at intervals to penetrate the parietal pericardium and pleura and the muscular coats of the esophagus at intervals to innervate its intrinsic structures. It is highly significant that finer trunks of the anterior and posterior complexes in places ran for distances of up to 3 cm. between the longitudinal muscle fibers of the esophagus and emerged more caudally to anastomose with other trunks, this finding occurring in one or more instances in 76 per cent of specimens. This finding again would be of relatively minor academic interest were it not for the fact that in eleven instances (22 per cent) a fine trunk disappeared beneath the longitudinal muscle layer of the anterior esophagus above the diaphragm and reappeared from beneath the same muscle layer on the anterior aspect of the stomach. (Figs. 6, 8, 10 and 12.) This phenomenon has also been observed by Abbott.[40]

The textbooks of anatomy point out that the anterior and posterior gastric nerves consist of fibers from both right and left vagi. A variable number of nerve bundles passed from the anteriormost trunks of the upper half or two-thirds of the right or posterior complex, caudad and toward the left on the anterior aspect of the esophagus to join the various branches or trunks of the anterior complex and contribute to the anterior gastric nerves, but without standard pattern. This occurred in forty-eight of the fifty specimens (96 per cent) examined in the series. It consequently became impossible often to determine how far to the right the limit of the anterior complex lay, or how far to the left the anterior limit of the right or posterior complex extended. A fusion zone of trunks containing neurons from both right and left vagus nerves widened downward, often absorbing or being absorbed into the anterior complex and giving rise to one or more anterior gastric nerves while contributing often also to the posterior gastric nerve.

Invariably one or more trunks passed from the upper third or half of the anterior complex down the left lateral and posterolateral aspects of the esophagus to join the posterior complex in its caudal two-thirds, often the branch with the largest diameter joining the posterior gastric nerve just above the level of the esophageal hiatus. (Figs. 6 and 8.) Again, a fusion zone existed posteriorly between anterior and posterior complexes, here absorbing or being absorbed into the right or posterior complex and giving rise to the posterior gastric nerve(s).

Classically the anterior complex is said to be amalgamated into a single anterior gastric nerve at a variable distance cephalad of the esophageal hiatus, and a similar phenomenon is reputed to occur posteriorly. The anterior gastric nerve is

said to pass through the hiatus on the left anterolateral aspect of the esophagus and the posterior on the right posterolateral aspect thereof. From the statistical data presented it is evident that the posterior trunks passed through the hiatus fused into one or two trunks which generally occupied a more constant position in relation to the esophagus than did the anterior.

Subdiaphragmatically, as McCrea[19,41] and Latarjet[13] observed, the distribution of the anterior and posterior gastric nerves was less variable than at any level below the bifurcation of the trachea. The anterior gastric nerve(s) divided very close to the esophageal hiatus into three to six branches, those of smaller diameter running toward the greater curvature of the stomach at right angles to the axis of the stomach, branching and to a variable degree regrouping into finer rami which eventually penetrated the muscular coats of the stomach wall beyond which they could not be followed macroscopically. This has been described as the left group of branches by McCrea and as the anterior gastric plexus by Sobotta[42] when the anastomoses between the branches are plentiful. Consistently there was a branch of the anterior gastric nerve running caudad along the lesser curvature with descending branches of the left gastric artery to the incisura. From this branch, which Latarjet has called the principal anterior nerve of the lesser curvature, many smaller rami arose to run perpendicularly toward the greater curvature, and to this nerve may be added anastomosing rami from the left group of branches. One or more branches of the anterior gastric nerve were found between the leaves of the lesser omentum running toward the hilum of the liver. (Figs. 5, 6 and 7.) These branches and a possible third nerve paralleling the principal nerve of the lesser curvature on its left side constitute the right branches described by McCrea.

The posterior gastric nerve(s) passed cauded, often 1 to 1.5 cm. to the right of the lesser curvature of the stomach, the largest terminal branch accompanying the left gastric artery to end in the celiac ganglion. Branches of the posterior gastric nerve(s) arose from 1 to 2 cm. below the esophageal hiatus and 2 to 3 cm. from the celiac ganglion. Similar to those anteriorly, the branches ran approximately perpendicularly to the trunk onto the posterior aspect of the stomach, divided and to a variable extent regrouped into branches of increasing number and decreasing caliber eventually diving into the musculature of the stomach. Where the anastomoses were common, this was similarly called a posterior gastric plexus. Still other branches of the posterior gastric nerve followed the lesser curvature toward the incisura angularis (the principal posterior nerve of the lesser curvature of Latarjet) and in turn gave off smaller branches running perpendicular to the axis of the stomach onto its posterior aspect. In nine instances branches of the posterior gastric nerve(s) arising at or below the esophageal hiatus passed onto the anterior aspect of the stomach, usually anastomosing macroscopically (contrary to the statements of Latarjet) with branches of the anterior gastric nerve. (Figs. 3, 9, 11 and 12.) This was commonly found by McCrea.

TABLE 1

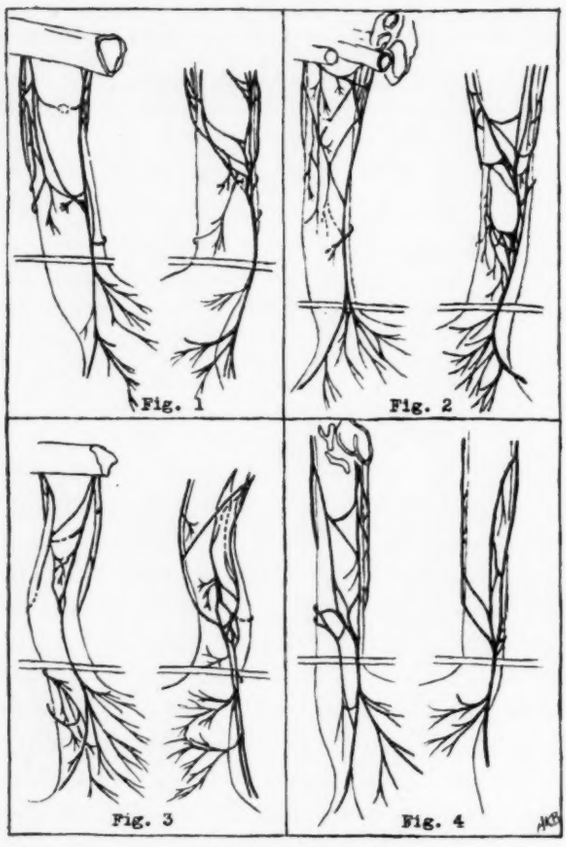
CLASSIFICATION OF THE PATTERN OF THE VAGUS INNERVATION OF THE STOMACH AT THE ESOPHAGEAL HIATUS (FIFTY CONSECUTIVE CADAVERS)

Group	No.	Per cent
I. Single anterior and posterior trunks...	7	14
II. One anterior and two posterior trunks.	4	8
III. Two anterior and one posterior trunks.	13	26
IV. Two anterior and two posterior trunks.	7	14
V. Three or more anterior and one posterior trunks.....	10	20
VI. Three or more anterior and two or more posterior trunks.....	9	18

In reviewing the individual dissections of this series, it appeared that classification was feasible on the basis of the complexity and number of gastric nerve trunks on the esophagus at and just above the esophageal hiatus. More than 3 cm. above the hiatus

the branching and anastomosing of the nerves of the esophagus lay in such divergent patterns as could be described only in the general terms above.

Group I. The simplest pattern found was that illustrated in Figures 1 and 2.



FIGS. 1 to 4. The left sketch in each figure represents the anterior aspect of the lower esophagus from the lung root to the esophageal hiatus and the anterior aspect of the stomach down to the incisura. The right sketch represents the posterior aspect. Dotted lines indicate intramuscular course of the vagus nerve fibers. (1) Single anterior and posterior gastric nerves at the esophageal hiatus (Group I); (2) high branching of the anterior gastric nerve (Group I); (3) single anterior and double posterior gastric nerves at the esophageal hiatus (Group II), with two posterior branches curving onto the anterior aspect of the stomach; (4) double anterior and single posterior gastric nerves (Group III). The right anterior trunk is about one-third the diameter of the left.

Here the trunks of the anterior complex united into a single anterior gastric nerve 1 to 3 cm. above the esophageal hiatus in six instances and at 7 cm. above in one instance. The trunks of the posterior complex united into a single nerve in all seven specimens somewhere from the hiatus to a level 2 cm. above it.

Three of the seven specimens in this group showed the anterior gastric nerve beginning to divide into its terminal branches just above the level of the diaphragm. (Fig. 2.) In all seven instances the anterior gastric nerve passed through the esophageal hiatus between the anterior midline of the esophagus and its left border, and the posterior nerve passed through between the right border of the esophagus and a point one-third of the way across its posterior aspect toward the left border. The configurations of anterior and posterior gastric nerves in this small group are similar to the ninety-two described by Bradley and his associates[1] and to thirty described by Chamberlin and Winship.[43]

Group II. A somewhat more complex pattern obtained in four specimens in which one anterior and two posterior gastric nerves passed through the esophageal hiatus. (Fig. 3.) The anterior trunks again occupied the same relative position to the esophagus as in the group just described, and both posterior trunks passed through the hiatus just posterior to the right border of the esophagus, the two trunks being not more than 0.3 cm. apart.

Two specimens showed these posterior trunks reuniting into a single trunk 1.5 cm. below the esophageal hiatus. In the other specimens wherein the trunks remained separate, the right trunk of the pair sent a communicating branch arising below the diaphragm onto the anterior aspect of the stomach. (Fig. 3.)

Group III. In thirteen specimens, a quarter of the total number of dissections, two gastric nerves passed through the esophageal hiatus anteriorly and one posteriorly. This occurred in five of the thirteen cases illustrated in the paper of Miller and Davis.[3]

In nine of the thirteen cadavers of this series the larger of the two anterior trunks was on the left, in eight being situated as in Group I on the left anterior half of the esophagus (Fig. 4), and in one within 0.4 cm. of the right border of the esophagus in anteroposterior projection. In

these nine specimens the two trunks were separated by as much as 1.0 cm. or as little as 0.2 cm. at the level of the esophageal hiatus. In one specimen of the subgroup of eight the smaller anterior nerve ran through the hiatus deep to the longitudinal muscle layer of the esophagus, the nerve penetrating to this position 1.5 cm. above the diaphragm and promptly sending two communicating branches above the diaphragm, both deep also to the longitudinal coat, to join the larger anterior nerve. (Fig. 6.) In three of the four remaining specimens, the two anterior trunks were of equal size and not more than 0.3 cm. apart. (Fig. 5.)

Usually the two anterior gastric nerves anastomosed on the anterior aspect of the stomach within 1.5 cm. of the undersurface of the diaphragm. Communicating rami linked the two anterior gastric nerves on the anterior surface of the lower esophagus within 3.5 cm. of the upper surface of the diaphragm. Consequently the smaller branch would be identified if the larger trunk were found and dissection of the trunk carried above or below the diaphragm for the distances indicated.

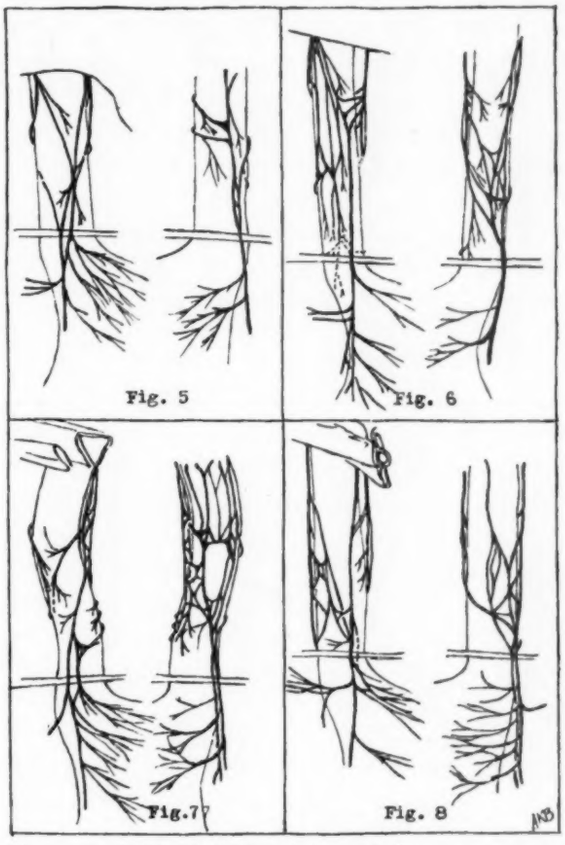
In three specimens the right-sided anterior trunk seemed to be composed exclusively of fibers arising from the lateral or anterolateral aspect of the right or posterior complex and passing downward constantly more to the left to converge with the larger anterior gastric nerve within 0.2 cm. of the undersurface of the diaphragm.

Group IV. Seven dissections disclosed a fourth possible pattern with two gastric nerves passing through the esophageal hiatus anteriorly and two posteriorly. (Figs. 7 and 8.)

The two posterior trunks occupied the position behind the right border of the esophagus and showed the proximity to each other already noted in Group II. Some of the anterior trunks, as in Group III, arose largely from the right or posterior complex and joined the other anterior gastric nerve subdiaphragmatically, after passing through the hiatus somewhere between the anterior midline of the esophagus and its projected right border. This phenomenon merely represented a caudal displacement of some of the communicating trunks from the anterior limits of the posterior or right complex joining the left or anterior complex.

Of the seven dissections, three showed the smaller anterior trunk running through the hiatus deep to the longitudinal muscle layer in the fashion already described. (Fig. 8.)

Group V. Of equal complexity with Group IV was a group of ten cadavers pos-

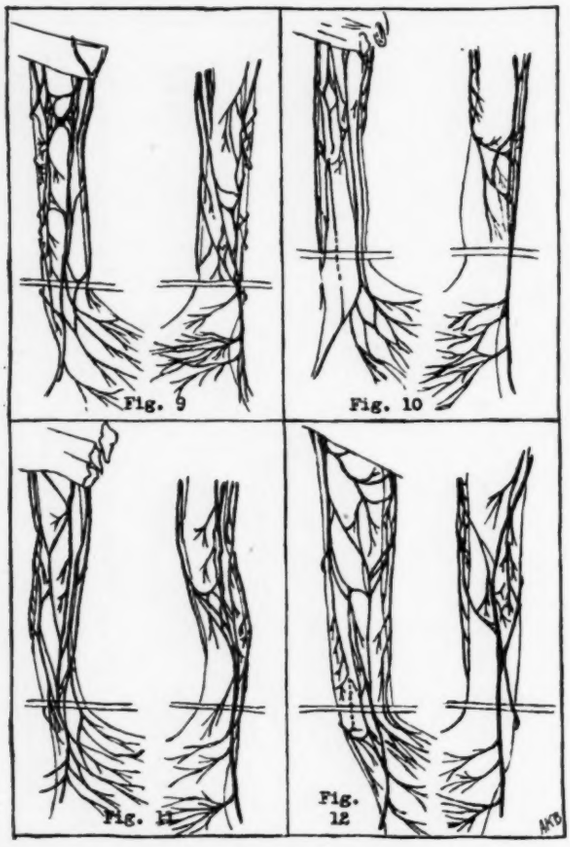


Figs. 5 to 8. The left sketch in each figure represents the anterior aspect of the lower esophagus from the lung root to the esophageal hiatus and the anterior aspect of the stomach down to the incisura. The right sketch represents the posterior aspect. Dotted lines indicate intramuscular course of the vagus nerve fibers. (5) Double anterior and single posterior gastric nerves (Group III), the anterior trunks of equal caliber; (6) double anterior and single posterior gastric nerves (Group III), one anterior nerve intramuscular in position; (7) double anterior and posterior gastric nerves (Group IV); (8) double anterior and posterior gastric nerves (Group IV), one anterior nerve intramuscular in position.

sessing three or more anterior gastric nerves passing through the esophageal hiatus and one posteriorly. (Figs. 9 and 10.)

Usually one anterior trunk possessed a diameter two to three times that of the others. The finer anterior gastric nerves passed through the hiatus both to the right and left of this

larger trunk all the way across the anterior aspect of the esophagus. Within 2.5 cm. below the diaphragm these trunks anastomosed with each other, giving origin to the usual left and right branches found on the anterior aspect of the stomach. In three specimens one or two



FIGS. 9 to 12. The left sketch in each figure represents the anterior aspect of the lower esophagus from the lung root to the esophageal hiatus and the anterior aspect of the stomach down to the incisura. The right sketch represents the posterior aspect. Dotted lines indicate intramuscular course of the vagus nerve fibers. (9) Three or more anterior gastric nerves and a single posterior nerve (Group v); (10) three or more anterior gastric nerves and a single posterior nerve (Group v), one of the anterior nerves intramuscular in position; (11) three or more anterior gastric nerves and two or more posterior nerves (Group vi); (12) three or more anterior gastric nerves and two posterior nerves (Group vi), one of the anterior nerves intramuscular in position.

anterior trunks ran through the hiatus submuscularly. (Fig. 10.)

Group VI. The most complex configurations of all, nine in number, consisted in three or more nerve trunks passing through the hiatus anteriorly and two or more nerve trunks posteriorly. (Figs. 11 and 12.)

Four of the nine dissections showed one or more anterior nerve trunks to be submuscular. (Fig. 12.) It would be arbitrary in these nine specimens to set any caudal limit on the anterior complex branching which continued onto the anterior aspect to the stomach; the esophageal plexus had no caudal fusion into one or two anterior gastric nerves but branching and anastomosing continued until the terminal branches to the stomach were given off. This is illustrated in Sobotta[42] and described by Kollmann.[44]

TABLE II

PER CENT OF SUBJECTS SHOWING SINGLE ANTERIOR AND POSTERIOR GASTRIC NERVES AT THE ESOPHAGEAL HIATUS ACCORDING TO RECENT ANATOMIC STUDIES

Author	No. of Subjects	Material	No. with Only Two Gastric Nerves	
			No.	Per cent
Bradley and associates	100	Autopsy	92	(92)
Miller and Davis	13	Autopsy	5	(38)
Chamberlin and Winshin	50	Embalmed	30	(60)
Boyd	50	Embalmed	7	(14)

The investigations of Bradley and his associates[1,2] revealed that in sixty-four of their one hundred dissections the various trunks of the anterior and posterior complexes fused into common right or posterior and left or anterior trunks somewhere between the esophageal hiatus and a level 6 cm. above it. In seven of the specimens the point of fusion was at the esophageal hiatus, and in twenty-one long right or posterior and left or anterior trunks were present caudad from somewhere above the 6 cm. level. The total of these cases represented 92 per cent of their dissections. In the series of thirteen dissections by Miller and Davis[3] only five specimens showed single right or posterior and left or anterior trunks at or just above the esophageal hiatus. Three or more gastric nerves passed

through the hiatus anteriorly and posteriorly in the remaining eight. Statistical analysis reveals that these results are significantly at variance. The statistics derived from the dissections performed in this series likewise differ significantly from those of the former group of investigators but not from those of the latter group. The investigations of Chamberlin and Winship[43] showed that thirty of fifty dissected specimens had single anterior and posterior gastric nerves, the remaining twenty being of a more complex pattern. These results also are significantly different from the statistics of Bradley and his co-workers. In the series reported here only eleven of fifty specimens had single anterior gastric nerves and twenty-nine of fifty had single posterior nerves. In only seven of the fifty cases (Group 1) were single anterior and posterior gastric nerves simultaneously present.

The dissected specimens have been classified into six groups of increasing complexity on the basis of the number of trunks passing through the esophageal hiatus anteriorly and posteriorly. It was apparent, throughout, that less variation in position and number of trunks characterized the trunks on the posterior aspect of the esophagus at the hiatus. A glance at the accompanying illustrations will convince one that though the posterior gastric nerves were situated usually behind the right border of the esophagus at the level of the hiatus (forty-eight of fifty specimens), the anterior fibers were located anywhere from the right to the left border although the largest trunk was more commonly (forty of fifty specimens) in the usual left anterior location. The ease of location of this larger trunk must not blind one to the fact that there were additional anterior trunks in thirty-nine instances (78 per cent). The existence of so many additional anterior fibers made a statistical determination of the caudal limit of the anterior complex an arbitrary and rather meaningless matter since it could be determined accurately in so few instances. Again, dissections carried 5 cm. above and 2.5 cm. below the level of the diaphragm along one or two largest anterior trunks turned up communicating branches leading to the other smaller anterior trunks.

The foregoing study indicates that since there are eleven instances of single anterior gastric nerves and twenty-nine of single posterior nerves, the pattern of the gastric nerves about the esophageal hiatus is usually complex and that the performance of a complete vagotomy will not be accomplished in the vast majority of cases with the division of only one trunk on either aspect of the esophagus.

The transthoracic approach to the vagus nerves is usually accomplished through the bed of the seventh or eighth left rib and costal cartilage. The left pulmonary ligament is divided and the posterior mediastinal pleura opened. The trunks of the vagi are identified as they approach the sides of the esophagus from the posterior aspect of the lung roots, dissected downward and removed. The anterior and posterior gastric nerves are identified at the level of the esophageal hiatus and these trunks are dissected upward and removed. The rent in the mediastinal pleura is then sutured and the chest closed without drainage. The procedure should include stripping of the esophagus of all adventitious tissue down to the longitudinal muscle layer save the principal left-sided arterial supply.

It has been the custom in this clinic to perform vagotomy subdiaphragmatically through an upper midline abdominal incision or a curved transverse incision roughly paralleling the inferior margin of the thoracic cage. The left lobe of the liver is mobilized to the right by division of the left triangular ligament. The esophagus is freed of its attachments to the hiatus and drawn down at least 6 to 8 cm. into the peritoneal cavity. The largest anterior gastric nerve is easily identified, being usually 0.2 to 0.3 cm. in diameter. It can be followed upward and downward, its communicating branches in turn identify-

ing the other anterior gastric nerves. All adventitious tissue is removed from the anterior aspect of the esophagus down to the longitudinal muscle layer for a distance of 8 cm. over the lower esophagus and upper stomach. Pathologic examination of this tissue has revealed therein the presence of several nerve bundles which had not been determined at the operating table. The esophagus and upper stomach have then been rotated through 180 degrees to permit the performance of a similar procedure posteriorly. The constancy of location and relatively larger size of the posterior gastric nerves permit their easy identification. The same stripping is carried out equally wide posteriorly.

The majority of surgeons of the clinic believe that the subdiaphragmatic approach is preferable by reason of the opportunity presented to explore the abdominal viscera, the ease of examining the ulcer-bearing area, and the ease of performing a drainage operation if deemed advisable. As Walters and his associates[2,30] have already pointed out, the abdominal exploration will occasionally turn up another unsuspected pathologic finding, such as a Meckel's diverticulum.

Abdominal exploration simultaneously permits confirmation of the diagnosis and appreciation of scarring of the pylorus which may require the performance of gastric resection or gastroenterostomy. Since numerous cases of marked postvagotomy gastric retention are being reported, some surgeons believe that gastroenterostomy should be performed simultaneously in the majority of cases.

SUMMARY

1. In dissections of fifty adult, thoroughly fixed cadavers, the vagus nerves passed from the posterior aspects of the lung roots to the sides of the esophagus in two to five trunks on each side.

2. These trunks descended obliquely, branching and anastomosing, the left passing to the anterior and left lateral aspect of the esophagus and the right to the posterior and right posterolateral aspect of the esophagus.

3. There were several branches passing from the right or posterior complex downward anteriorly to join the anterior complex, and one or more branches passing posteriorly to the esophagus and downward from the anterior complex to join the posterior complex, these branches serving to render the lateral limits of the two complexes indefinite.

4. Passing through the esophageal hiatus in seven specimens there were single anterior and posterior gastric nerves; in four specimens, one anterior and two posterior nerves; in thirteen specimens, one posterior and two anterior nerves; in seven instances, two anterior and two posterior nerves; in ten specimens, three or more anterior and one posterior nerves; and in nine specimens, three or more anterior and two or more posterior nerves.

5. Subdiaphragmatically, the anterior nerve(s) split close to the hiatus into left and right terminal branches. The left branches split off to the left and were distributed to the anterior gastric wall, the fibers running perpendicularly to the axis of the stomach as do the branches of the principal nerve of the lesser curvature. The right branches consisted of one or more branches running through the lesser omentum to the liver, the principal nerve of the lesser curvature and one or more running along the lesser curvature to the incisura with branches of the left gastric artery.

6. Subdiaphragmatically, the largest branch of the posterior gastric nerve(s) terminated in the celiac ganglion, other branches following the lesser curvature and all branches being distributed to the posterior aspect of the stomach perpendicularly to its axis, the branches arising from 1 to 2 cm. below the hiatus caudad.

7. In 76 per cent of dissections nerve trunks passed caudad for variable distances between fibers of the longitudinal muscle layers of the esophagus, and in 22 per cent of specimens one or more trunks passed

through the esophageal hiatus in this fashion.

8. In all instances in which more than one trunk passed through the hiatus anteriorly, dissection along the largest anterior trunk 5 cm. above the hiatus and 2.5 cm. below revealed communicating rami to the less obvious trunks also passing through the hiatus anteriorly. More than one trunk passed through the hiatus anteriorly in 78 per cent of cases.

9. Throughout the dissections the posterior gastric nerve(s) showed less variation than the anterior nerve(s) at the hiatus, being located in 96 per cent of specimens between the posterior midline of the esophagus and the right border; and if present as two trunks, these usually were no more than 0.4 cm. apart at the level of the hiatus.

10. Anterior gastric nerve trunks could not be so dependably localized, being somewhere on the anterior aspect of the esophagus at the hiatus, although the largest trunk in 80 per cent of specimens was situated somewhere between the anterior midline and left border of the esophagus.

11. Complete vagotomy can be accomplished only by stripping the esophagus (and upper stomach in subdiaphragmatic approaches) of all obvious nerve trunks and adventitious tissue down to the outer longitudinal muscle layer over a distance of not less than 8 cm.

12. It is believed that vagotomy is technically feasible through the abdomen. This approach offers the advantages of simultaneous exploration of the abdominal viscera, examination of the ulcer-bearing area and easy performance of drainage operations or revisions of previous operations.

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TREATMENT OF ACUTE PERITONITIS WITH AUREOMYCIN*

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THE advent of chemotherapy as an adjunct in the management of acute peritonitis has been followed by a significant reduction in mortality. The work of Crile,[1] Altmeier,[2] Rothenberg and colleagues[3] and others has established the efficacy of penicillin in massive doses and the role of streptomycin and sulfadiazine in the therapy of this condition. Despite adequate surgery and efficient postoperative care it seems evident that none of the present day antibacterial agents has given a final answer, for a residual mortality still exists.

The extremely wide antibacterial spectrum possessed by aureomycin as shown by many studies[4–9] was an important factor prompting the use of the drug in peritonitis of all types. The mixed intestinal flora frequently found in the abdomen at the time of operation seemed logically to fit the capacities of this new antibiotic. Further, the limitations of penicillin, sulfonamides and streptomycin, alone and combined, in handling certain cases of peritonitis, coupled with the fact that our experience at Harlem Hospital has not been in line with the extremely low mortality rates recently reported in the literature, made the search for another therapeutic agent particularly desirable. This paper is a preliminary report on the use of aureomycin in the treatment of fifty-two unselected patients with acute peritonitis due to appendicitis, perforated ulcers (gastric or duodenal) and one case of perforated sigmoid diverticulum.

The group of patients was representative of that found in the average municipal hospital, comprising that section of our population which is economically insecure, nutritionally deficient, physically impaired and deprived, in most instances, of adequate educational opportunities.

Using previously known antibiotics and a standardized postoperative regimen the over-all mortality in 406 cases of acute appendicitis at Harlem Hospital for the years 1946 and 1947 was found by Maynard[10] to be 4.18 per cent. There were 145 cases of acute peritonitis in this group with fifteen deaths, a mortality of 10.3 per cent. In forty cases of perforated gastroduodenal ulcers during the same period there were seven deaths with a mortality of 17 per cent. These patients received penicillin and sulfadiazine postoperatively. According to Maingot[11] the current mortality of perforated ulcers in the average general hospital varies from 8 to 15 per cent. Olsen and Nogore[12] report a 21 per cent surgical mortality in perforated ulcers for the seven years, 1938 to 1944. Luer,[13] covering a ten-year period, showed an 18.2 per cent mortality. Recent reports on appendicitis with peritonitis show a reduction of mortality to between 3 and 4 per cent and lower.[1,2,14,15]

The fifty-two cases reported in this series are analyzed in Table 1.

All but one of these patients was treated definitely by surgical intervention in an effort to remove the offending disorder and prevent further seeding of the already invaded peritoneal cavity. Drainage was instituted in 95 per cent of these cases. The surgery was performed by the resident staff under the supervision of assistant

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visiting surgeons. The age in appendical peritonitis ranged from four to sixty-eight years, and in perforated ulcers from twenty-eight to sixty-five years. For the purpose of this paper the type of peritonitis encountered was divided into two large categories, localized and spreading or generalized. In the appendicitis group there were nineteen cases of localized and sixteen cases of generalized peritonitis, with perforation found in 75 per cent of the cases. There were sixteen cases of generalized peritonitis in the ulcer group; in the case of the perforated sigmoid diverticulum the peritonitis was localized at the time of operation.

In this series of fifty-two cases there were four deaths. Two of these are included in our final mortality figures as possibly not having responded to the antibiotic although these deaths occurred early in the study at which time relatively low intramuscular dosages were used. The remaining two are excluded because postmorten findings proved them to be surgical mortalities.

In the initial phases of this study cases were alternated for control purposes, using penicillin and other antibiotics in one group and aureomycin in the second group. After approximately twenty-four cases were followed in this manner results with aureomycin were sufficiently impressive to warrant its use in all cases of peritonitis.

Bacteriologic control was established at the time of operation by culturing the fluid found in the abdominal cavity. These findings are presented in Table II.

In addition to determining the bacteriology at operation, cultures were obtained at frequent intervals from the in-dwelling abdominal drain until its time of removal. This procedure was followed routinely in an effort to obtain some information as to the bacterial flora present in the peritoneal cavity. At the present time we can draw no conclusions regarding this phase of the work but will discuss and analyze our findings in detail in a later paper.

As anticipated, Escherichia coli was the predominant organism isolated from appendical peritonitis. In all but one case it appeared in combination with one or more organisms, usually streptococci. Although anaerobes were found in some cases, the incidence was not as frequent as has been reported in some other studies.[3,16,17] In this type of disease a mixed flora was found far more commonly than was a pure culture although no single outstanding grouping of organisms presented itself. On the other hand, pure cultures were the rule rather than the exception in perforated ulcers. Probably because of early surgical intervention and the location of the lesion in the gastrointestinal tract, Escherichia coli was found in only three cases, two of which were fatal. The significance of these findings is not clearly evident at present since

TABLE I
ANALYSIS OF FIFTY-TWO CASES IN WHICH AUREOMYCIN ALONE WAS USED

Disease	Total		Operative Procedure	Type of Peritonitis		Mortality, Per cent	
	No. of Cases	No. of Deaths		Localized	Generalized	Uncorrected	Corrected
Appendicitis	35	2	Appendectomy 32*	19	16	5.71	2.94
Perforated gastroduodenal ulcers	16	2	Repair perforation 16	0	16	12.5	6.67
Sigmoid diverticulum	1	0	Drainage 1	1	0	0.0	0.0
Totals	52	4	.....	20	32	7.69	4

* One non-operative case; two drainage.

TABLE II
OPERATIVE BACTERIAL CULTURES ACCORDING TO TYPE OF DISEASE

Thirty-five Cases of Appendicitis with Peritonitis	No. of Cases
Escherichia coli plus anaerobic streptococci	3
Escherichia coli plus gamma streptococci	2
Escherichia coli plus Streptococcus viridans	1
Escherichia coli plus Aerobacter aerogenes plus gamma streptococci	1
Escherichia coli plus anaerobic streptococci plus Clostridium perfringens	1
Escherichia coli plus gamma streptococci plus Staphylococcus albus	1
Paracolon bacilli plus Bacteroides funduliformis	1
Streptococcus viridans plus coagulase positive beta hemolytic Staphylococcus aureus	1
Beta hemolytic streptococci	1
Streptococcus viridans	1
Gamma streptococci	1
Escherichia coli	1
Staphylococcus albus plus Micrococcus pyogenes var. albus	1
Escherichia coli plus anaerobic streptococci plus Clostridium perfringens plus Bacteriodes funduliformis plus Bacteriodes melaninogenicus	1
Escherichia coli plus Aerobacter aerogenes plus paracolon bacillus	1
Escherichia coli plus Aerobacter aerogenes plus Corynebacterium pseudodiphthericum plus anaerobic streptococci plus Clostridium perfringens	1
Escherichia coli plus Corynebacterium pseudodiphthericum plus Micrococcus candidus	1
Anaerobic streptococci plus Micrococcus pyogenes var. albus Micrococcus anearobius	1
Corynebacterium pesudodiphthericum plus Bacteriodes melaninogenicus	1
Streptococcus viridans plus Klebsiella pneumoniae plus Staphylococcus albus plus Clostridium tetanosporum plus Bacteriodes funduliformis plus Micrococcus pyogenes var. albus	1
Anaerobic streptococci (this patient died)	1
Anaerobic streptococci plus Bacteriodes funduliformis (this patient died)	1
No culture—non-operative case	1
Negative	8
Sixteen Cases of Ruptured Gastroduodenal Ulcers	
Anaerobic streptococci	3
Beta hemolytic streptococci	1
Streptococcus viridans	1
Streptococcus viridans plus gamma streptococci	1
Anaerobic streptococci plus Staphylococcus albus plus Streptococcus viridans plus Clostridium tetanosporum plus Bacteriodes melaninogenicus plus Bacillus sp	1
Coagulase positive beta hemolytic Staphylococcus albus plus Corynebacterium pseudodiphthericum	1
Beta hemolytic streptococci plus Staphylococcus albus plus Escherichia coli plus Corynebacterium pseudodiphthericum plus Bacteriodes funduliformis plus anaerobic streptococci	1
Escherichia coli (these patients died)	2
No culture taken	1
Negative	4
One Case of Perforated Diverticulum	
Aerobacter aerogenes	1

there appears to be no clear-cut correlation between the bacteriology and the clinical course of the disease. (Table III.)

The percentage of negative cultures as shown in Tables II and III would appear to be high, particularly in peritonitis due to appendicitis. Partial explanation of these findings is related to inadequate culturing at the time of operation and the failure on the part of the house staff to follow necessary technical procedures. In the future we hope to reduce our number of negative cultures by taking swabs from the pathologic lesion in addition to those of the abdominal fluid.

The mortality in this series of fifty-two cases is presented in Table IV.

The basis of evaluation of the four deaths was the appraisal of aureomycin's failure to control or prevent the fatal termination of the peritonitis. Thus, two deaths were automatically dropped from our fatality percentage, for both were proven to be surgical deaths at postmortem examination. One death was due to a "blow-out" of the appendical stump, and in the second case two patent ulcers were found on the posterior wall of the first part of the duodenum and were feeding the peritoneal cavity from a retroperitoneal abscess. Of the other two deaths, one occurred in a forty-five year old colored male with a perforated appendix who died suddenly three and one-half days postoperatively from a pulmonary embolus. The diagnosis was made by x-ray and clinical findings; no postmortem was obtained. The second death was in a sixty-five year old white female, acutely ill, with a perforated gastric ulcer, estimated at about eighty-six hours' duration prior to operation. The patient lived for forty hours after operative intervention during which period aureomycin was administered. The inclusion of two deaths in the series to date gives an over-all mortality of 4 per cent; a 2.94 per cent mortality in appendical peritonitis; and a 6.67 per cent mortality in perforated ulcer cases. While our series is too small as yet to draw any definite conclusions regarding the efficacy of aureomycin, comparison

TABLE III

CORRELATIONS BETWEEN CLINICAL COURSE OF DISEASE AND BACTERIOLOGY

Case No.	Age	Disease	Organism	Hospital Days	Course	Complication
1	37	Perforated gastric ulcer	Beta hemolytic streptococci	13	Uneventful	None
2	34	Appendical abscess	Non-operative case	23	Uneventful	None
3	28	Gastric ulcer	Negative	18	Uneventful	None
4	34	Appendicitis	Negative	9	Uneventful	None
5	43	Gastric ulcer	Anaerobic streptococci	36	Stormy	Chest, extremities, intra-abdominal abscess, wound infection
6	5	Appendicitis	Paracolon bacilli plus Bacteroides funduliformis	13	Uneventful	None
7	38	Gastric ulcer	No operative culture	20	Moderate	Chest, wound infection
8	9	Appendicitis	Micrococcus anaerobius	12	Uneventful	None
9	33	Appendicitis	Negative	9	Uneventful	None
10	46	Appendicitis	Escherichia coli plus gamma streptococci plus Staphylococcus albus	20	Stormy	Chest, abdomen, genito-urinary, wound abscess
11	48	Gastric ulcer	Negative	22	Uneventful	None
12	5	Appendicitis	Escherichia coli plus anaerobic streptococci plus Clostridium perfringens	24	Stormy	Wound abscess
13	32	Duodenal ulcer	Gamma streptococci plus Streptococcus viridans	20	Stormy	Chest, wound abscess
14	46	Gastric ulcer	Negative	24	Uneventful	None
15	43	Appendicitis	Negative	10	Mild	Chest
16	38	Appendicitis	Beta hemolytic streptococci	12	Uneventful	None
17	34	Appendicitis	Negative	19	Moderate	Chest
18	55	Sigmoid diverticulum	Aerobacter aerogenes	14	Uneventful	None
19	34	Duodenal ulcer	Anaerobic streptococci	37	Uneventful	None
20	21	Appendicitis	Streptococcus viridans plus coagulase positive hemolytic Staphylococcus aureus	9	Uneventful	None
21	24	Appendicitis	Streptococcus viridans	25	Stormy	Chest, pelvic abscess
22	59	Appendicitis	Escherichia coli plus Aerobacter aerogenes plus gamma streptococci	22	Moderate	Chest, wound abscess
23	7	Appendicitis	Escherichia coli plus gamma streptococci	13	Uneventful	None
24	47	Appendicitis	Negative	9	Uneventful	None
25	11	Appendicitis	Escherichia coli plus anaerobic streptococci	20	Mild	None
26	28	Duodenal ulcer	Streptococcus viridans	19	Moderate	Chest, wound infection
27	43	Gastric ulcer	Negative	16	Uneventful	None
28	4	Appendicitis	Escherichia coli	14	Uneventful; developed abscess at home	None
29	24	Appendicitis	Negative	11	Uneventful	None
30	25	Appendicitis	Negative	12	Uneventful	None
31	28	Appendical abscess	Escherichia coli plus gamma strepcocci	17	Mild	Diarrhea, three days
32	39	Appendicitis	Escherichia coli	18	Stormy	Fascial slough, thrombophlebitis
33	33	Gastric ulcer	Anaerobic streptococci	30	Stormy	Evisceration, delirium tremens, chest
34	15	Appendicitis	Negative	9	Uneventful	None
35	66	Appendicitis	Escherichia coli plus anaerobic streptococci	25	Uneventful	None
36	17	Appendicitis	Escherichia coli plus anaerobic streptococci	9	Uneventful	None

TABLE III (*Continued*)

Case No.	Age	Disease	Organism	Hospital Days	Course	Complication
37	30	Appendicitis	Staphylococcus albus plus Micrococcus pyogenes var. albus	9	Uneventful	None
38	49	Appendicitis	Gamma streptococci	11	Moderate	Pelvic abscess
39	69	Appendicitis	Escherichia coli plus anaerobic streptococci plus Clostridium perfrigens plus Bacteroides funduliformis plus Bacteroides melaninogenicus	22	Mild	Wound abscess
40	35	Appendicitis	Anaerobic streptococci plus Micrococcus pyogenes var. albus	20	Moderate	Wound abscess
41	21	Appendicitis	Escherichia coli plus Micrococcus candidus plus Corynebacterium pseudodiphthericum	13	Mild	Ileus
42	9	Appendicitis	Bacteroides melaninogenicus plus Corynebacterium pseudodiphthericum	15	Uneventful	None
43	42	Appendicitis	Streptococcus viridans plus Klebsiella pneumoniae plus Clostridium tetanosporum plus Bacteroides funduliformis plus Staphylococcus albus plus Micrococcus pyogenes var. albus	13	Moderate	Ileus
44	24	Duodenal ulcer	Coagulase positive beta hemolytic Staphylococcus albus plus Corynebacterium pseudodiphthericum	14	Uneventful	None
45	24	Duodenal ulcer	Streptococcus viridans plus Staphylococcus albus plus Bacteroides melaninogenicus plus Clostridium tetanosporum plus Bacillus sp. plus anaerobic streptococci	16	Uneventful	None
46	47	Appendicitis	Escherichia coli plus Aerobacter aerogenes plus paracolon bacilli	10	Mild	Wound infection
47	33	Duodenal ulcer	Beta hemolytic streptococci plus Staphylococcus albus plus Escherichia coli plus Corynebacterium pseudodiphthericum plus Bacteroides funduliformis plus anaerobic streptococci	19	Uneventful	None
48	42	Appendicitis	Escherichia coli plus Aerobacter aerogenes plus Corynebacterium pseudodiphthericum plus anaerobic streptococci plus Clostridium perfringens	14	Mild	Postoperative pneumonia
49	65	Duodenal ulcer	Escherichia coli	40 hours	Patient died of peritonitis	
50	28	Duodenal ulcer	Escherichia coli	10	Patient died of peritonitis	
51	45	Appendicitis	Anaerobic streptococci plus Bacteroides funduliformis	4	Patient died of pulmonary embolus	
52	42	Appendicitis	Anaerobic streptococci	10	Patient died of peritonitis	

with previous mortality figures at this hospital is very encouraging and further studies with the drug are indicated.

Aureomycin* can be administered by either the intramuscular, intravenous or oral route, apparently being clinically effective regardless of the method used. Initially, only intramuscular aureomycin was available and the search for an optimum dosage level began with this form of the drug. It was quickly apparent that our original dosages were too low, for despite clinical improvement morbidity was often prolonged. Clinical response to the drug was used as the basis for increasing the dosage rather than correlating the mg. dosage to Kg. of body weight. As soon as sufficient amounts of the antibiotic became available, the other two methods were used by choice. Since the combined intravenous and oral regimen we have had no fatalities.

In the first patients treated by the intravenous route, our daily dosage ranged up to 2 Gm. in an effort to find the minimal dose giving optimum clinical response. When it was determined that clinical results were very good with 1 Gm. of drug daily, we established the standardized routine described below which has been followed in all of our later cases. Immediately postoperatively the patient is given a 500 mg. intravenous dose and this is repeated every twelve hours thereafter for generally forty-eight hours. On the third postoperative day the Wangensteen suction is clamped off and two 250 mg. capsules are given orally every twelve hours for an average period of seven to ten days depending upon clinical indications. In children, the same general scheme has been followed but dosage has been cut approximately in half. For intravenous use the dry powder is dissolved in a 500 cc. flask of 5 per cent glucose in distilled water and introduced within an hour. This is given as part of the usual postoperative intravenous administration of fluids. In out hands this has proven to be a simple and efficient means for administering the drug.

To date there have been no toxic responses to the drug severe enough to cause cessation of therapy, regardless of the route of administration. When the intramuscular route is used, the only reaction has been some slight pain on injection. When given intravenously, a chemical phlebitis has developed in ten out of twenty-two cases, and it has ranged from mild to moderately severe. This complication did not alter the usual course of the disease nor prolong morbidity. With oral administration it is particularly interesting to note that we have not seen the nausea and vomiting or

TABLE IV
MORTALITY

Patient	Hospital Number	Onset to Operation (hr.)	Diagnosis	Time Lived	Cause of Death
A.O.	12196	26	Perforated ulcer	10 hr.	Uncontrolled peritonitis; no autopsy
L.M.	16581	72	Gangrenous appendicitis with generalized peritonitis	3½ days	Pulmonary infarction (by x-ray and clinical); no autopsy
W. H.	12072	26	Perforated ulcer	10 days	Patent duodenal ulcers 2, peritonitis; postmortem
J. F.	17059	40	Gangrenous appendicitis with peritonitis	10 days	Appendical stump "blow out"; massive intra-abdominal and retroperitoneal abscess; postmortem

* The aureomycin was supplied through the courtesy of the Lederle Laboratories, Division of the American Cyanamid Company, Pearl River, New York.

the type of diarrhea seen occasionally in other patients that have been treated in this hospital for ulcerative colitis (fifteen cases), various wound infections (sixty cases), compound fractures (ten cases) and genitourinary infections (twelve cases). In two cases there was mild nausea and some vomiting, but an interpretation of this was difficult because of the peritonitis present. Laboratory studies have shown no changes in blood chemistry, and urine studies have shown no evidence of kidney damage.

Blood levels have been determined in several cases and demonstrable levels have been found at all times with both the oral and intravenous route. At present, no conclusions have been reached as to the optimum therapeutic blood level.

SUMMARY

1. This is a preliminary report of the use of aureomycin in the treatment of fifty-two unselected patients with acute peritonitis due to appendicitis, perforated gastroduodenal ulcers and one perforated diverticulum.

2. There has been a definite reduction of mortality in this small series when compared with our hospital mortality for the previous two years. All deaths occurred prior to the introduction of the intravenous-oral therapeutic regimen.

3. The bacteriologic findings were inconclusive when correlated with clinical course. A mixed flora was the common finding in appendical peritonitis while a pure culture was the usual finding in perforated ulcers.

4. The combination of initial intravenous dosage followed, as soon as feasible, by oral administration of the drug has proven clinically to be the most successful procedure. Five hundred mg. of the drug with 500 cc. of 5 per cent glucose in water as the vehicle was given by infusion twice daily. As soon as Wangensteen suction could be safely interrupted, oral dosage of 500 mg. twice daily was begun and usually continued for an average of seven to ten days.

5. Minimal toxic reactions were noted. The drug produced a chemical phlebitis in some patients but did not prolong the course of the disease.

6. Aureomycin has proven to be of significant value in the therapy of peritonitis. Our series is too small to define the precise role of the antibiotic in this grave infection but results are impressive enough to warrant further extensive clinical investigation of the drug.

7. This work is still in progress and a detailed report will be published at a later date.

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Smith and Jordon studied 600 cases of gastric ulceration and found malignancy in about 10 per cent. This incidence is not great enough to permit one to generalize and affirm that all patients with gastric ulcers should be subjected to a subtotal gastrectomy. Gastric malignancy seems to occur much more frequently in men but, unfortunately, the clinical symptoms between benign and malignant gastric ulceration are too similar to permit a careful evaluation and differentiation. A greater percentage of gastric ulcers of the fundus and/or of the greater curvature becomes malignant than in other parts of the stomach. A benign duodenal ulcer can coexist with a malignant gastric ulcer, hence, the coexistence of these two types of ulceration cannot be used as an argument in favor of the gastric lesion being benign. However, if a gastric ulcer does not respond to a proper medical regimen after a period of two months or if it recurs, surgical resection of a major part of the stomach is usually justified even though often only a benign gastric lesion will be found. (*Richard A. Leonardo, M.D.*)

INJECTION INTO THE INTERCOSTAL NERVES FOR THE RELIEF OF POSTOPERATIVE PAIN*

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FOR a long time many surgeons have sought an entirely satisfactory analgesic agent which would relieve postoperative pain. A convalescent period free from pain would be not only a great boon from a humanistic viewpoint but would add materially to the smoothness and rapidity of convalescence. For example, surgeons have been particularly cognizant of an inhibited respiratory function after operation on the upper portion of the abdomen. Patey, Churchill and McNeil, Zollinger and Powers have independently demonstrated a decrease in vital capacity after surgical procedures on the abdomen. Narcotics have been invaluable agents in combatting postoperative pain and discomfort. Unfortunately, they have undesirable side effects which are chiefly depressant in nature. The processes of respiration, bowel activity and micturition, already burdened by a surgical procedure, may be further embarrassed by heavy sedation. Obviously, a postoperative period free of pain would have many advantages.

In recent years attention has been directed to regional anesthesia as a possible means of preventing postoperative pain. Crile in 1918 employed local wound infiltration with quinine and urea in conjunction with his anoci-association theory of anesthesia. Capelle in 1935, however, was the first to employ this principle with the idea of allaying postoperative pain and thereby increasing pulmonary ventilation. By means of retention needles he infused the incised area continuously with a solution of procaine hydrochloride. Gius later reported improvement in two cases of postoperative atelectasis after paravertebral block with procaine hydrochloride. Zollinger apparently was the first to study the effect of intercostal nerve block in regard to convalescence after operation. After the intercostal nerves were blocked by the injection of a solution of eucupine and procaine hydrochloride in oil, he found a definite increase in vital capacity during the immediate postoperative period. Starr and Gilman have reported similar results. Belinkoff[2–4] studied a series of 100 patients who underwent abdominal operation, in which he produced intercostal block with a solution of monocaine and benzyl alcohol in oil. More than 80 per cent of the patients had a smooth convalescence as a result. According to McCleery, Zollinger and Lenahan in a series of cases which they reported recently, intercostal block was produced successfully, postoperatively, with nupercaine in oil in approximately half of the patients who received the injections. In those cases in which the block was effective, the authors found an increase in vital capacity after operation and a decrease in pulmonary complications and narcotic requirements. However, the controls used in some of these studies just referred to might seem open to question.

INJECTION

Method. The method used to inject the anesthetic solution into the intercostal nerves was essentially the same as that described by Bartlett, Zollinger and Belinkoff[2]. Two and one-half to 3 cc. of the anesthetic agent was injected into each of the intercostal nerves from the sixth to the eleventh, inclusive. When the incision was some distance from the midline, only the ipsilateral nerves were blocked. If a transverse, midline or near-midline incision was

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necessary, bilateral intercostal block was induced. All injections were administered immediately on completion of the operation. Hollinshead and McCleery and his co-workers have stated that the anteroposterior site of the injections may be

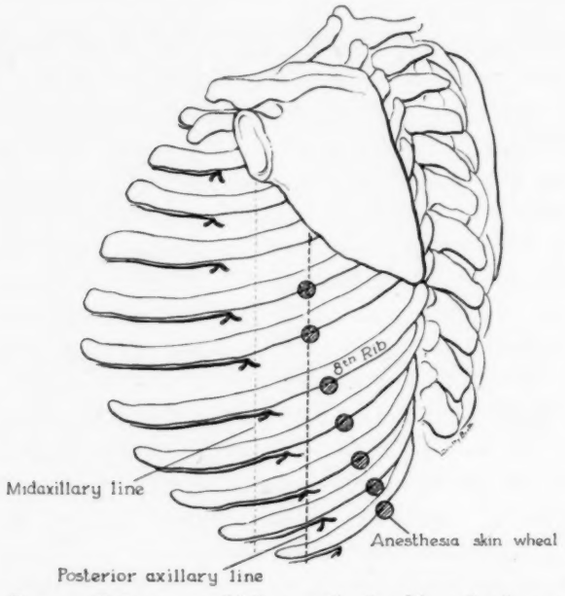

FIG. 1. Points at which anesthetic skin wheals are made. Through these wheals needles are inserted into the regions of the intercostal nerves.

important. Infiltration of the intercostal nerve proximal to its division into lateral cutaneous and anterior branches probably offers greatest assurance of a complete block. This can be accomplished by injection of the anesthetic solution into the sixth intercostal nerve in the posterior axillary line and by injection of the solution into the succeeding intercostal nerves, in a line that extends gradually, posterolaterally from that point. Figure 1 illustrates the sites of infiltration which were employed in this study. Some investigators have feared that regional block in this area would involve the motor innervation of the abdominal musculature and that weakness would result. As will be discussed later, the anesthetic agent employed in this work has no effect on motor components of nerves.

Anesthetic Agent Employed. The choice of a suitable anesthetic agent presented a problem. One was desired which would be effective for a minimum of four days after operation. Initially, a cocaine derivative in oil was used and intercostal block was produced in ten patients. It did not seem to be effective, however, for a sufficient period. A commercial solution of ammonium sulfate known as "dolamin"* was then considered. Dolamin is composed of benzyl alcohol 0.75 per cent, ammonium sulfate 0.75 per cent, and sodium chloride 0.48 per cent in sterile water. Judovich and Bates have demonstrated experimentally that the ammonium ion obliterates C fiber potentials when injected into a nerve trunk. This selective action relieves pain although it has no effect on skin sensation or on motor components of the nerve trunks.

Experimental and clinical observations have shown that the ammonium ion relieves pain effectively for a matter of hours to three or four days or longer. In our experience the effect of this drug usually persists for at least several days. Lundy has had considerable clinical experience with this agent in the treatment of various neurologic, intractable and postoperative pain. He has found it effective in well over 50 per cent of the cases and in a higher percentage than this when the needles used for the injection were placed accurately with the help of roentgenograms. MacCarty has injected dolamin into the intercostal nerves under direct vision when he has performed thoracolumbar sympathectomy. He believes that patients so treated suffer much less pain during convalescence. Flashman and Lundy employed dolamin to induce paravertebral block in a case of crushing injury of the thorax. There was immediate diminution of pain and increase in pulmonary ventilation. Dolamin has satisfied most of the requirements of an ideal anesthetic agent for infiltration of the intercostal nerves. It is non-toxic, effective over a prolonged period and has a selective action on pain-conducting mechanism. Dolamin was therefore employed throughout our study.

* Dolamin is prepared by Harvey Laboratories, Philadelphia, Pennsylvania.

METHOD OF STUDY

Series 1. *Procedure:* Fifty patients who required operation on the upper portion of the abdomen were studied. Dolamin was used in some cases to produce intercostal block while the control group received only intercostal injections of sterile isotonic solution of sodium chloride. Only the anesthetists knew the type of solution used in each case and selection of the patients followed no set pattern. During the postoperative period an attempt was made by the house and staff doctors in attendance to determine in each case whether dolamin or isotonic solution of sodium chloride had been injected. It was thought that this method would afford more reliable information than if the doctor who attempted to evaluate the effectiveness of the injection knew what solution had been used.

TABLE I
OPERATIVE PROCEDURES PERFORMED IN SERIES I

Procedures	No. of Patients
Gastric resection	18
Cholecystectomy	14
Vagotomy and gastro-enterostomy	3
Cholecystectomy and choledochostomy	3
Other procedures	12
Total	50

Evaluation of the injections was carried out on a basis of subjective pain, narcotic requirements, physiologic functions (respiration and micturition in particular) and postoperative complications. It was soon apparent that the results were not dramatic. Clinical criteria do not exist by which patients' pain and discomfort can be definitely evaluated on a comparative basis. Thresholds of pain are so unpredictable that subjective expression is almost valueless from a statistic standpoint. It was rarely possible to state unequivocally that a given patient had had an injection of dolamin to produce intercostal block and that another patient had received only isotonic solution of sodium chloride. Table 1 lists the type of operative procedures performed on the patients in series 1.

Results: On the basis of clinical observations it was thought that twenty-eight patients had received dolamin and twenty-two patients had received isotonic solution of sodium chloride. This interpretation was checked with the records of the Section on Anesthesiology. The number of cases in which dolamin was injected and the number of cases in which isotonic solution of sodium chloride was injected are shown in Table 11. Correct interpretations were made in 63 per cent of the cases in which dolamin was injected and in 60 per cent of the cases in which isotonic solution of sodium chloride was injected. Theoretically, if a difference had not been noted in these two groups of patients, the results in 50 per cent of the cases in each group would have been interpreted correctly. The results therefore indicate some beneficial effect from the injection of dolamin as compared with isotonic solution of sodium chloride although the difference is not striking.

TABLE II
CLINICAL ANALYSIS OF INFILTRATION OF INTERCOSTAL NERVES WITH DOLAMIN OR ISOTONIC SOLUTION OF SODIUM CHLORIDE

Solution	Patients	Clinical Interpretation		Correct Interpretations, Per cent
		Injected	Not Injected	
Dolamin	30	19	11	63
Isotonic solution of sodium chloride	20	12	8	60

The average requirement for narcotics was somewhat lower among the patients who received dolamin than among the control series. (Table 111.) An average of 4.5 hypodermic injections of a narcotic was required for each patient in the former group and an average of 5.2 injections for each patient in the latter group. This shows a slight but perhaps insignificant difference. The incidence of urinary dysfunction and other complications was approximately the

same for both groups. (Table III.) As shown in Table IV the incidence of pulmonary complications was relatively high (four cases of atelectasis or 13 per cent) among those who received injections of dolamin; there were no instances among the control series. This would appear to be coincidental and not statistically important. Some investigators have reported occasional instances of pneumothorax or pleural effusion which resulted from intercostal block. These complications were not encountered in this series.

TABLE III
COMPARATIVE EFFECT OF INTERCOSTAL INJECTION WITH DOLAMIN OR STERILE ISOTONIC SOLUTION OF SODIUM CHLORIDE ON POSTOPERATIVE NARCOTIC REQUIREMENTS, URINARY FUNCTION AND COMPLICATIONS

Solution	No. of Cases	Narcotics, Average Number Hypodermic Injections*	Catheterizations		Complications	
			No.	Per cent	No.	Per cent
Dolamin	30	4.5	15	50	8	26.6
Isotonic solution of sodium chloride	20	5.2	11	55	5	25.0

* The figures represent the average number of hypodermic injections for each patient given during the postoperative period. Any administration of morphine or equally potent narcotic was considered a unit.

Series 2. Procedure: Study of the results in the fifty cases in series 1 showed that dolamin was somewhat favored for intercostal nerve block for the relief of postoperative pain; the results, however, were not unequivocal. From a purely objective standpoint, the most tangible criterion of pain was the narcotic requirement. There was some question as to whether or not this factor had been controlled carefully enough. Nurses may administer a hypodermic injection for "restlessness" at bedtime although the patient may be having little or no pain. To obviate this situation, if possible, it was decided to study a series of patients to whom narcotics were given postoperatively only on the specific order of a house doctor, and only when the patients definitely complained of pain. In series 2, 100 consecutive patients who had had major operations on the upper portion of the abdomen, were studied with this plan in effect. Fifty patients received dolamin for intercostal block and fifty patients received no intercostal injection whatever. In the cases in which injections were given the method used was identical to that employed in the first series of cases. Comparative results in the experimental and control groups were based on narcotic requirements, urinary dysfunction and other complications. (Table V.)

TABLE IV
POSTOPERATIVE COMPLICATIONS ENCOUNTERED IN SERIES 1

Complication	Patients	
	Injected with Dolamin	Injected with Isotonic Solution of Sodium Chloride
Thrombophlebitis, suspected or proved	0	3
Atelectasis, presumptive and proved	4	0
Ileus, severe abdominal distention, or both	1	2
Wound infection (mild)	1	0
Urinary infection (mild)	1	0
Peritonitis (death resulted on sixteenth day; operation, total gastrectomy for carcinoma)	1	0
Total	8	5

Results: Patients in series 2 who received dolamin to produce intercostal nerve block required an average of 4 doses of a narcotic during the postoperative period. Patients in whom intercostal block was not produced required an average of 4.6 doses. (Table VI.) The incidence of urinary dysfunction and other complications was the

same for the two groups. In each group there were two instances (an incidence of 4 per cent) of pulmonary complications, each of which was a case of atelectasis. (Table VII.) There were three deaths in series 2 (Table VII); none of them was related in any way to the intercostal injections.

TABLE V
OPERATIVE PROCEDURES IN SERIES 2

Procedure	No. of Patients
Gastric resection	37
Cholecystectomy	16
Cholecystectomy and choledochostomy	9
Exploration for inoperable carcinoma	9
Abdominal vagotomy and gastro-enterostomy	4
Exploratory laparotomy	4
Transthoracic vagotomy	3
Choledocholithotomy	3
Other surgical procedures	15
Total	100

TABLE VI
EFFECT OF POSTOPERATIVE INJECTION WITH DOLAMIN ON NARCOTIC REQUIREMENT, URINARY FUNCTION AND COMPLICATION—SERIES 2

	No. of Patients	Hypodermic Injections, Average Number	Catheterizations		Complications	
			Patients	Per cent	Patients	Per cent
Dolamin injected	50	4.0	15	30	10	20
No intercostal injection	50	4.6	15	30	11	22

TABLE VII
POSTOPERATIVE COMPLICATIONS—SERIES 2

Complications	Intercostal Nerve Block, Dolamin	No Block
Atelectasis	2	2
Thrombophlebitis, suspected or proved	2	3
Severe abdominal distention	3	0
Mild infection or slight separation of wound	0	3
Urinary infection	1	1
Pulmonary embolism (ligation of femoral vein)	1	0
Peritonitis (death on ninth day after gastrectomy for carcinoma)	0	1
Gastric hemorrhage (death on twelfth day after operation for inoperable carcinoma of stomach)	1	0
Hepatic coma (death on tenth day after operation for inoperable carcinoma of biliary system)	0	1
Total	10	11

An effort to control carefully the administration of narcotics after operation did not affect the results materially. In both series studied there is minimal though definite evidence that injection of the intercostal nerves with dolamin does diminish postoperative pain. Evidence is not present, however, that such injections have any influence on the incidence of postoperative complications. The factor of early ambulation may have some bearing on this finding. Without exception all patients in both series were ambulatory either the evening of the day of operation or the day after. Undoubtedly, ambulation tends to augment all physiologic functions, particularly those of respiration, micturition and intestinal activity. It is not inconceivable that the advantages of early ambulation, which were active in both the experimental and control groups, have accounted for a considerable portion of the gain envisioned in the abatement of postoperative pain by means of intercostal nerve block.

COMMENT

We have found on further experience with dolamin that this drug is an effective anesthetic agent when it is used to infiltrate sensory nerves and that its action usually persists for from a few hours to three or four days. On the basis of the current study it is obvious that intercostal injection of dolamin at the conclusion of various operative procedures on the upper part of the abdomen does not uniformly allay postoperative pain to a significant degree in a large majority of cases. On the other hand, a few patients experienced only minimal pain in the region of the incision after injection of dolamin. It is also true that approximately 60 per cent of

patients who had received an intercostal injection of dolamin postoperatively experienced a sufficient analgesic effect from this treatment to be recognized clinically when compared with a control group of patients who had received an injection of isotonic solution of sodium chloride. From this study one concludes that although an analgesic drug such as dolamin, injected intercostally, may afford partial relief to some patients, it leaves considerable to be desired from the viewpoint of the ideal remedy for relief of all postoperative pain. This statement is, of course, based on the assumption that the substance used was injected accurately into the intercostal nerves or into the tissues in the immediate vicinity of the nerves and that it is an effective analgesic agent. In an attempt to interpret the results of this study one must, of course, consider the possibility that a major portion of pain which is experienced postoperatively is not mediated through the skeletal nerves. These results seemed worthy of mention as they are somewhat at variance with other articles on the subject.

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SKELETAL PINNING AND EXTERNAL FIXATION

PROS AND CONS

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TREATMENT of fractures is a constant challenge to the surgeon because no two fractures are identical. A fracture of a long bone at a certain level usually produces a more or less characteristic deformity. If the fracture is transverse, oblique or comminuted, there may well be a variation of the deformity. Fractures near or into joints also come into this category. It is these unusual variations that pose perplexing problems.

No one method of treatment can be used to advantage in all fracture cases or in all cases that are somewhat similar. Closed reduction and application of a cast is effective and applicable in the majority of cases. Open reduction can be used in many other cases but is merely a form of internal fixation and often additional external fixation is also necessary. Still other patients are best treated by traction although this necessitates a long period of bed rest undesirable in any case but particularly risky for elderly individuals.

In 1942, having encountered a number of particularly difficult fractures that could not be as satisfactorily treated by any of the more common methods, the author investigated skeletal pinning and external fixation. It is an old, old method of treatment revived in recent years. Several types of apparatus are available bearing the developers' names, Roger Anderson, Stader and Haynes to mention a few. All have the same underlying principle, namely, multiple pins inserted into the bone at different angles and then fixed by means of external bars connected to the pins by clamps. Some use free pins while others have pins in a bar that necessitate the use of fixed angles of insertion. The apparatus which has free pins is more universally adaptable to unusual situations.

Recently the treatment of fractures by means of pins and bars was termed the "ambulatory treatment." Many of the profession are under the impression that this means weight-bearing is obtainable. This is not true. The expression was coined to illustrate how patients with fractures ordinarily treated with traction and bed rest can now be up and about on crutches.

The advocates of skeletal pinning and external fixation attribute to it certain virtues. The multiple pins inserted at a "V" angle seemed to give perfect control of both fragments in any direction. The use of a reduction frame permitted anatomic approximation with a minimum of manipulation. Fixation of the pins with easily applied external rods maintained the reduction. The equipment was light in weight and caused the patient little discomfort. Furthermore, the joints above and below the fracture were free to move, thus preventing stiffness of the joints.

After purchasing our apparatus, we made an intensive study of proper application. While the equipment looks simple and its application easy, it soon became apparent that there was much to learn. First there are particular sites at which the pins should be inserted, not only for anatomic reasons but to obtain the best mechanical advantage. Before inserting the pins it is preferable to obtain approximate reduction for the soft tissues must be considered. The pins should be located where there is a minimum of motion. Use of the proper size pins to stand the strain is important. A light pin bends and causes pressure necrosis in the bone or soft tissues. It is also advisable

to insert the pins with a hand chuck to avoid heat necrosis of the bone. When necrosis occurs, the pins loosen. All of this is mentioned to emphasize one very important point, namely, in all surgical procedures, one must be very familiar with the method in order to use it correctly.

One technic or several technics for the use of skeletal pinning and external fixation have been worked out for the treatment of practically every type of fracture. The author has used many but not all of the procedures. As he gained experience with the method he began to limit its use to certain selected cases, those in which simpler methods were not as suitable. The reasons are as follows: (1) Insertion of pins is usually slower than closed reduction and casting. Local anesthesia can be used but general anesthesia is usually indicated. Minimizing this is considered important. (2) Anatomic reduction with reduction apparatus is not quite as simple as it appears to be. Functional approximation is often obtained easier by other forms of treatment. (3) Drainage from around the pins is annoying. It is produced by pressure necrosis of the soft tissue and is only occasionally purulent in nature. (4) Occasionally pins loosen due to pressure or heat necrosis of bone. When this occurs, the treatment has to be modified. Additional pins must be added or all pins removed and immobilization obtained by a cast or traction. (5) Joint motion often is not as great as might be expected. This is because the pins traverse movable soft tissue with resultant pain. Movement is thus protectively minimized.

Complications of one kind or another develop in a certain percentage of all surgical cases. Fracture cases are no exception. It is our constant desire to alleviate these complications that drives us to perfect our technics and develop newer and better methods.

Osteomyelitis is one of the complications that has always been the greatest argument against the use of pins or wires. It is believed that motion of the pin from side to side permits access of infection. The use of multiple pins inserted at an angle through both cortices gives the greatest bearing surface or holding surface possible in the bone and limits motion of the pins. Whenever motion develops either with multiple pins or a single pin, it is due to loosening from necrosis caused by pressure or heat. It can occur and does occur even with multiple pins, and when motion does develop the probability of infection is greater. If osteomyelitis occurs after pinning, a ring sequestrum is almost always present. These are difficult to demonstrate by x-ray unless the pin hole is viewed on end. Currettement of the pin hole usually provides a cure if done early.

If there is soft tissue movement about the pins, local infection is likely to develop. This may be a small affair but large abscesses in the fascial spaces have developed in our experience. They present a real problem that must be treated radically. Only in a few instances has it been necessary to remove the pins because of the infection. Extension of the infection into the bone has never occurred unless there was already concurrent loosening of the pin.

In spite of the above shortcomings and possible complications the author believes that the use of skeletal pinning and external fixation is of special value in certain cases in the following groups:

CASE REPORTS

CASE 1. *Fracture dislocations:* A twenty-eight year old soldier suffered multiple injuries in an automobile accident in August, 1943. He had a severe head injury and was in coma. There was an obvious fracture of the left femur with displacement of the proximal fragment typical of an anterior dislocation of the hip. The femur was placed in skin traction and all efforts directed toward treating the head injury and associated shock. It was thirteen days before his condition permitted definitive treatment of the fracture dislocation. Then under spinal anesthesia pins were placed in the proximal and distal fragments, the fracture reduced and external fixation applied. With an intact extremity, the dislocation was relatively

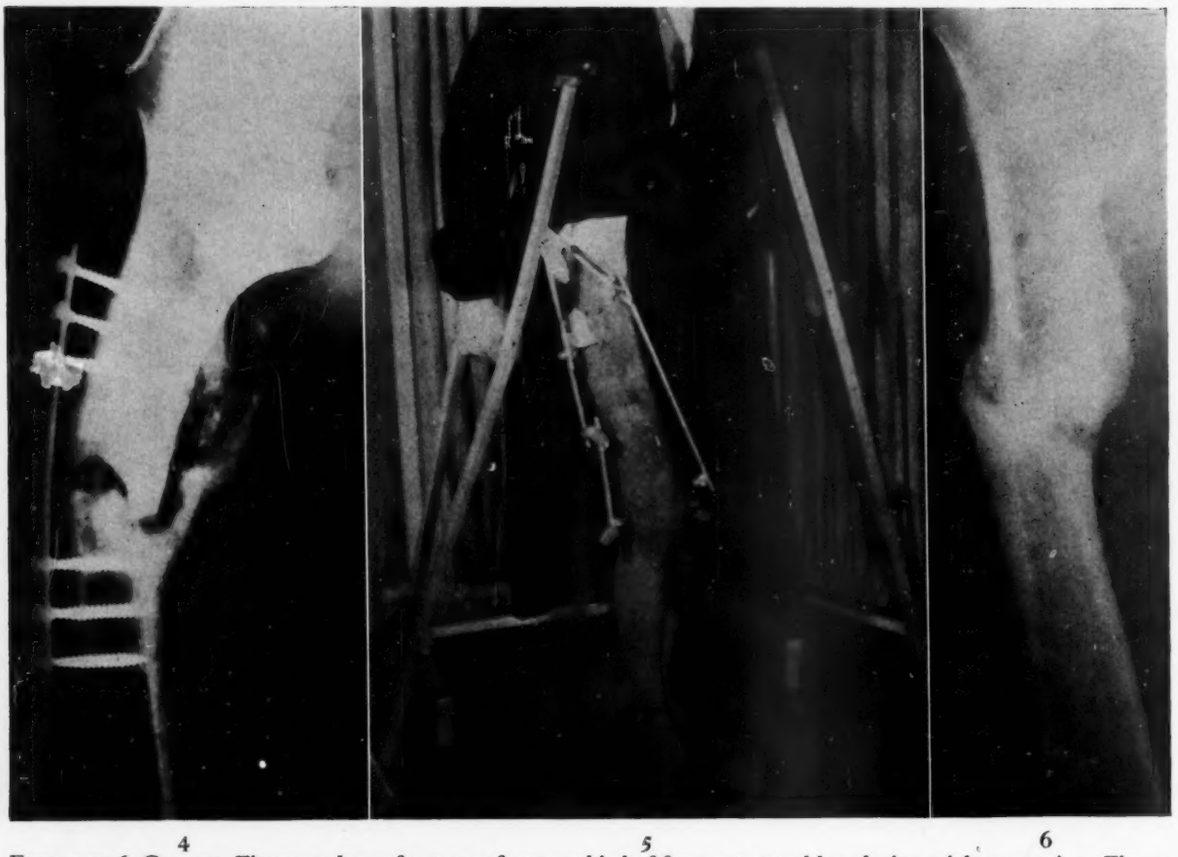
FIG. 1. Fracture of shaft of femur with anterior dislocation of hip; closed reduction of dislocation made possible by initial fixation of fractured fragments.

FIG. 2. Case I. Illustrating the arrangement of pins and bars and ease with which the patient can ambulate.

easily reduced with traction and manipulation. Some displacement of the fracture fragments occurred. They were realigned and solid healing of the fracture occurred in five months. Minimal residual limitation of flexion of the knee resulted. Follow-up films fifteen months after injury showed the head of the femur viable. (Figs. 1 and 2.)

CASE II. *Fractures into joints:* These can usually be treated only by traction through the joint. Occasionally open reduction and internal fixation with screws is possible. Skeletal pinning, however, is universally adaptable. Pins are placed in the major fragment and in the intact bone above or below the joint. The fracture fragments are reduced by manipulation using traction to take full advantage of the natural muscle and ligamentous pulls. These frequently produce reduction without direct molding. When reduction has been obtained, position is maintained by fixation with external rods. A thirty-eight year old soldier suffered a comminuted supracondylar fracture through the right humerus in a fall in July, 1943. This

FIG. 3. Case II. Epicondylar fracture of humerus into elbow joint fixed with skeletal pins and bars.



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FIGS. 4 to 6. Case III. Figure 4 shows fracture of upper third of femur, treated by plating with non-union; Figure 5 shows the patient ambulatory on crutches after removal of plate and correction of angulation; the end result six months later is shown in Figure 6.

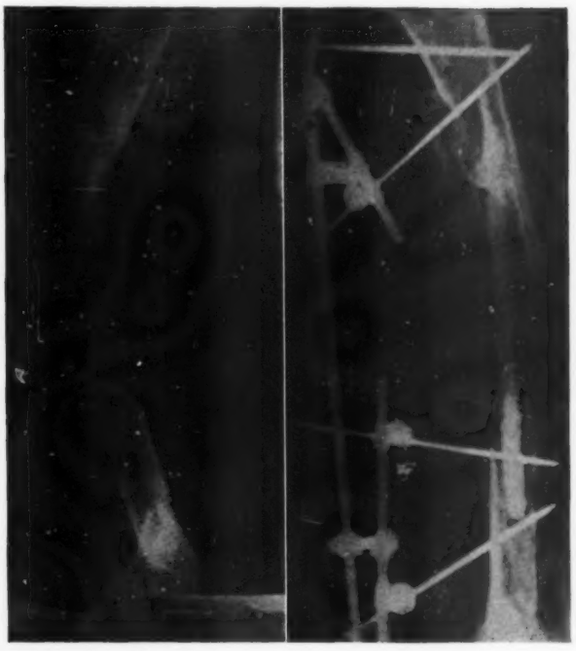
area was already deformed due to mal-union of an old fracture suffered in childhood. Marked hemorrhage into the soft tissues produced ischemia when the elbow was flexed to maintain reduction. Therefore, skeletal pins were inserted and fixed as seen in the accompanying illustration. The patient was quite comfortable. Good union was obtained and elbow motion was within 5 degrees of what it had been before refracture. (Fig. 3.)

CASE III. *Fractures of the femoral shaft:* This type of fracture is ordinarily treated by traction for a period of months or by open reduction and cast. Both methods limit the patient's activity a great deal. By using skeletal pins and external fixation reduction can be maintained and the patient's activity limited very little. Active patients can ambulate on crutches with ease while more feeble ones can be easily handled by attendants. A sixty-four year old doctor incurred a high shaft fracture of the femur which was treated by open reduction, plating and casting. Angulation at the fracture site occurred. He came to us ten months after injury with angulation and non-union. The plate and screws were removed, the bone ends freshened and realigned and position maintained by skeletal pins and external fixation. Good union was obtained. This patient was in a position to evaluate the spica cast and skeletal pinning treatments. He much preferred the latter. (Figs. 4 to 6.)

CASE IV. *Lower extremity fractures in handicapped patients, those with amputations or deformities of legs or arms that prevent use of crutches:* The lighter weight of the equipment permits the patient to handle himself better. (Fig. 7.)

CASE V. *Maintenance of position after arthrodesis:* The equipment is much less cumbersome than a spica after fusion of a knee yet will maintain position perfectly. Should some absorption of the bone at the point of fusion occur it is a simple matter to loosen the external bars, impact the bones and then reapply the external fixation. A tuberculous knee joint in a twenty-nine year old negro was fused. There was some strain on the pins as they were in-

FIG. 7. Case IV. Both bone fractures of lower leg in an amputee; the tibial caliper brace was applied for added protection.



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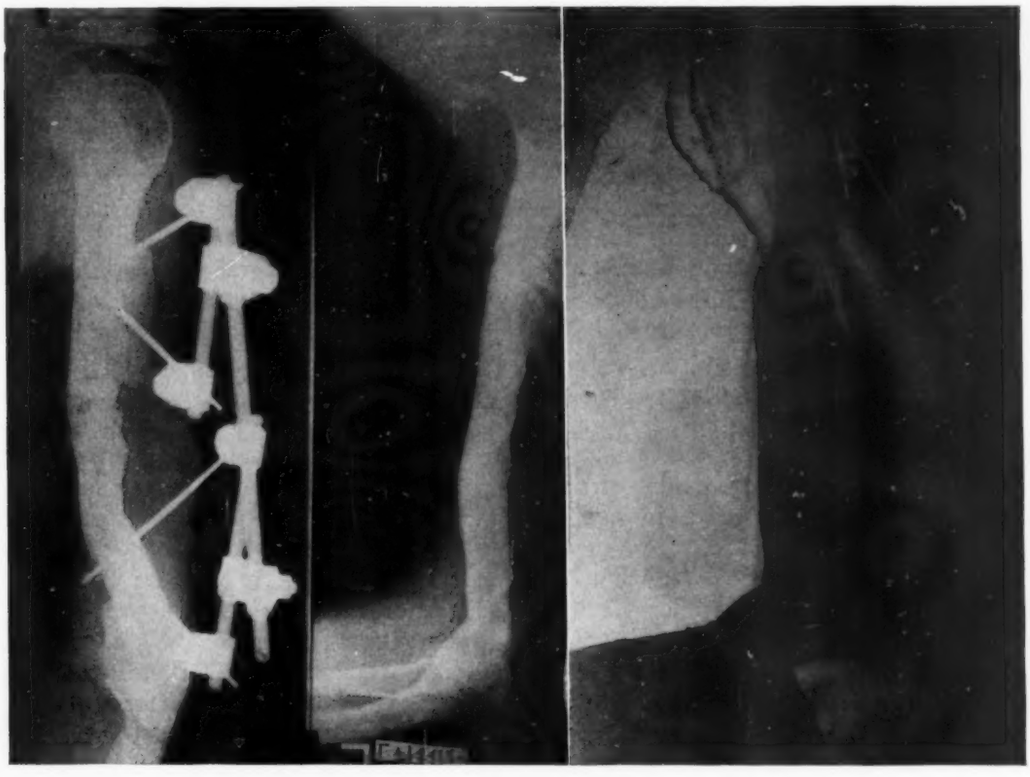
FIGS. 8 and 9. Case V. Figure 8 shows bone and soft tissue loss following extensive injury to upper arm; Figure 9 illustrates the utilization of pins to maintain position during and after bone grafting procedure.



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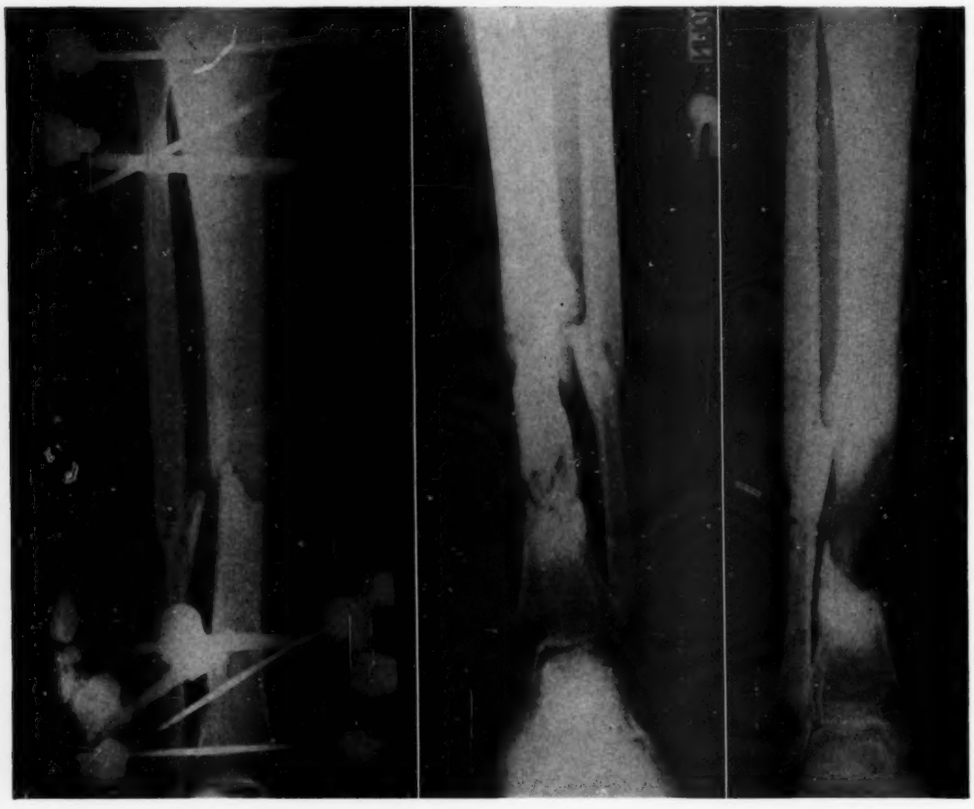
FIGS 10 and 11. Case V. Note growth of graft at end of five years shown in Figure 10. Fixation apparatus was applied because of recent fracture through graft. Figure 11 shows the present condition of arm; note marked soft tissue loss and scarring; functional result was remarkably good.



12 13 14

FIGS. 12 to 14. Case VI. Compound fracture of both bones of lower leg fixed with pins and external bars shown in Figure 12; Figure 13 shows sequestration occurring at the most proximal of the two distal pin sites; Figure 14 reveals the extent of bone loss following multiple sequestrectomies.

serted in this position and some of them loosened. Recently the technic has been modified to the point where additional pins are placed in the proximal femur and distal tibia as well. A much more solid fixation can thus be obtained.

CASE VI. *Maintenance of limb length in extensive bone loss:* Illustrated in Figures 8 to 14 is the case of a thirty-seven year old switch tender who was struck in the left arm by a railroad engine in 1941. There was marked soft tissue and bone loss. The patient almost died of hemorrhage. This prevented immediate definitive treatment. Severe infection developed and when this subsided a plaster shoulder spica was applied which the patient wore for seventeen months. A radial nerve palsy which developed immediately after injury was treated with physical therapy and cleared up during this time. Five months after all drainage had subsided the cast was removed, skeletal pins inserted and fixed and an intramedullary tibial graft put in place. The solid fixation in proper position made this procedure much easier than it would have been on a flail arm. The patient wore the apparatus for nineteen months without any discomfort or complications before it was believed that the arm was solid enough to remove all protection. He did his regular work during the greater part of this time. Due to the great soft tissue loss there was no muscular protection for the bone. This fact was brought to our attention time and time again. Since the patient was an alcoholic, he exposed himself to unnecessary situations such as tavern brawls and strong arming. The humerus has been fractured on five occasions since the grafting procedure. Police have taken him to the nearest hospital for treatment but the next day he always reports to us to have skeletal pins with external fixation applied. He much prefers it to a cast. With this form of treatment he is able to continue on his job. Because approximately the same pin sites were used on all occasions it became difficult to find solid cortex to hold the pins. On the last fracture it was thought that an onlay iliac bone graft might speed his recovery.

The thin layer of soft tissue proved a stumbling block. It was closed without tension over the graft but the circulation was poor and a slough occurred. Even a skin flap from the chest wall to cover the soft tissue defect did not take entirely. The bone graft was quite solid by the time soft tissue healing was obtained. But osteomyelitis developed in all the pin holes. The patient treated it himself for months. He reported for examination in June, 1948, and a sequestrectomy of all pin holes done. His progress has been satisfactory to date. Such a case as this seldom occurs in a life time of practice. The insertion of pins in the same area should probably not be done more than two or three times. But this patient so preferred skeletal pinning to the cast he had worn that it influenced our better judgment.

COMMENT

Few surgeons today advocate just one method of treatment for all types of fractures. Those who do arouse justifiable criticism. Such criticism may become so intense as to blind most surgeons to its merits even when indicated.

The great majority of fractures can be treated by the time honored closed reduction methods, namely, manual reduction and immobilization by cast or splints. The minority of fractures, the so-called selected cases, must be met by special methods: skeletal traction, open reduction and internal fixation by plate or screws, or bone grafting. These methods all necessitate prolonged bed rest or further immobilization by casts. The author contends that in certain of these selected cases skeletal pinning and external fixation is preferable. It offers an excellent method of securing healing with a minimum of inconvenience to the patient and with no greater danger of complications than exists in the aforementioned reduction procedures.

Infections either in the bone or the soft tissues are the bugaboo of all open reductions. Those surgeons who have mastered the "Lane technic" have reduced infections, not completely, but to a minimum. Some of these, confident of their ability to avoid complications, advocate plating or screws in many fractures in which the majority still secure good results by the closed methods. A few surgeons have equal confidence in their ability to avoid complications with the use of skeletal pinning and external fixation. These likewise have mastered the technic which minimizes infections. Both groups in their enthusiasm often give the impression that their methods are indicated in the majority of fractures.

The author emphasizes the value of closed reduction and simple immobilization for the majority of fractures. The merits of open reduction and fixation of the fragments by plate or screws when indicated are recognized. It is pointed out that there is a definite place for skeletal pinning and external fixation in certain selected cases.

SUMMARY

Arguments for and against the use of skeletal pinning and external fixation are discussed. Its use in certain selected cases is advocated. Illustrative case reports are presented.

ARTHRODESIS OF THE ANKLE JOINT*

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ARTHRODESIS has proven of value in relieving the disabling symptoms of paralytic deformities, traumatic arthritis and advanced infections involving the ankle joint. This was emphasized in an early follow-up of ten patients who had ankle arthrodeses between the years 1942 and 1945 in the Department of Orthopedic Surgery at the Hospital of the University of Pennsylvania.

The admitting diagnoses included five patients with residual paralytic deformities from anterior poliomyelitis, three patients with chronic arthritis following trauma and two patients with chronic infections, one of these tuberculosis.

Of the five patients with paralytic disabilities, there were four with extensive paralytic involvement of the entire extremity as well as the local complaint of flail foot. One had subluxation of the ankle joint with associated pain on weight-bearing. In the other four pain was not a complaint. Their chief indication for treatment was limitation of function and pronounced deformity. Three of the five paralytic patients needed further stabilization of the foot. Two had triple arthrodeses previous to ankle fusion, one a subastragalar arthrodesis at the time of ankle fusion and one had a talonavicular arthrodesis previous to ankle fusion and one at the time of ankle fusion.

The three patients with a diagnosis of traumatic arthritis complained chiefly of pain and marked restriction of motion. Three patients had previous fractures involving the ankle joint with healing in poor position; one, twenty years; one, two years; and one, four months previous to admission. Symptoms in these cases had arisen shortly after mobilization was begun and had increased with activity.

Two patients had severe osteomyelitis. In one of these the osteomyelitis resulted from a hunting accident in which a shotgun was discharged into the lower leg and ankle joint region ten months prior to admission, with a resultant comminuted compound fracture. The other case was that of a tuberculous infection of ten years' duration, with pain and marked destruction of the articulating surfaces.

A similar operative technic was followed in the ten cases. Under tourniquet a longitudinal midline or anterolateral incision was made. The periosteum was incised exposing the distal tibia, ankle joint and astragalus and the entire articular cartilage of the upper surface of the astragalus, tibia and fibula was cut away. Moderate deformity of the ankle joint was corrected at this time by adequate excision of bone from the apposing surfaces. Recesses which may remain following this should be filled with bone chips obtained when the tibial graft is taken. A full-thickness cortical graft approximately 1 inch wide and 2 inches long was removed from the tibia immediately above the joint surface. A gutter of suitable dimensions was cut from the anterior portion of the body and the superior surface of the neck of the astragalus. With the tibia and astragalus in proper alignment, the graft was moved across the anterior surface of the joint and countersunk into the prepared gutter in the astragalus. The wound was closed in layers followed by the application of a plaster cast maintaining the foot in proper equinus and the knee in moderate flexion. Equinus of 12 degrees beyond a right angle is con-

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sidered adequate for males unless compensation for unequal leg lengths is necessary. More equinus is indicated in the female, the amount depending on the height of heel to be worn.

Postoperative roentgenograms were used to determine accurately the degree of equinus. This was determined by the angle formed by a line drawn on the roentgenogram through the longitudinal axis of the tibia intersecting another line along the inferior margin of the os calcis extending to the inferior margin of the head of the first metatarsal. Correction of unsatisfac-

TABLE 1

Patient and Age	Diagnosis	Symptoms	Operation	Complications	Weight-bearing (mo.)	Bony Fusion	Function	Cosmetic
I. J. C., 36	Paralytic equino-varus	Pain on weight-bearing, instability	Triple arthrodesis 1/10/45, ankle fusion 1/24/45	None	3	Yes	Excellent	Slight residual forefoot varus
II. G. F., 15	Paralytic flail foot	Instability	Ankle fusion talonavicular fusion 3/14/45	None	6	No	Good	Good
III. B. F., 17	Paralytic flail foot	Instability	Ankle fusion astrag-scaphoid 11/30/42, subastrag-fusion 1938	Wound infection	14 as other procedures necessitated bed rest	Yes	Good	Good
IV. E. C., 18	Paralytic flail foot	Instability	Ankle fusion 9/23/42	None	3	Yes	Good	Good
V. H. H., 39	Paralytic flail foot	Instability	Triple arthrodesis 6/23/44, ankle fusion 1/3/45	None	3	Yes	Good	Good
VI. W. W., 54	Traumatic arthritis following fracture	Pain, limitation motion	Subastrag. and ankle arthrodesis 9/29/43	Wound infection	4	Yes	Good	Good
VII. O. J., 50	Traumatic arthritis following fracture dislocation	Pain, limitation motion	Ankle fusion 4/19/44	None	3	Yes	Good	Good
VIII. P. M., 53	Traumatic arthritis following fracture dislocation	Pain, limitation motion	Ankle fusion 11/13/44	None	4	Yes	Good	Good
IX. O. A., 36	Osteomyelitis ankle joint from gun-shot wound	Pain, purulent discharge	Ankle fusion 10/18/44	None	4	Yes	Good	Good
X. E. K., 22	Tuberculosis ankle joint	Purulent discharge, pain	Ankle fusion 11/6/44	Fracture of donor site 4 mo. postoperatively	8	Yes	Good	Good

tory position may be obtained by wedging the cast. For correction of inadequate equinus, the cast may be cut anteriorly over the ankle joint and the foot forced into more equinus. The wedge is removed posteriorly if more dorsiflexion is necessary. Accurate roentgenographic check of position is important as an awkward heel gait may develop if too little equinus is obtained. Excess equinus places strain on the forefoot.

Two months postoperatively the cast was removed for clinical and roentgenographic examinations of the ankle joint. If both examinations reveal satisfactory progression of the fusion, weight-bearing was begun in a snugly fitting plaster boot extending from the toes to the tibial tubercle. The sole of the boot was reinforced to withstand direct weight-bearing on the plaster. Nine of the ten patients began weight-bearing in plaster between two and three months postoperatively. After one month of weight-bearing in plaster the patient had his cast removed in order to allow further clinical and roentgenographic examinations. These examinations revealed adequate fusion in eight of the ten cases and the patients were permitted weight-bearing with no support other than adequate shoes. Of the two patients requiring a longer period of immobilization, one was that of a paralytic flail foot and this case obtained a fibrous union even after six months' immobilization following ankle fusion. However, the functional use of the foot was much improved. The other was that of tuberculosis in which weight-bearing was started at four months but immobilization was continued for eight months in an effort to obtain quiescence of the infectious process. In this case there was a fracture at the site of removal of the tibial graft. During the fourth month of the eight months' immobilization given this patient there was roentgenographic evidence of callus formation about the tibia at the site of the graft removal. The patient offered no complaints and there were no significant clinical findings. Subsequent roentgenograms showed evidence of complete healing.

The postoperative course of the ten patients was uneventful except for two wound infections which responded to conservative therapy and caused no subsequent diasability. Three representative cases are presented. The entire group have been summarized in Table 1.

CASE REPORTS

CASE V. A thirty-nine year old, white male had flaccid paralysis of the left lower extremity with resultant difficulty in walking and equinovarus deformity of the foot since an attack of anterior poliomyelitis when eight years old. On December 18, 1942, the patient suffered a fracture of the shaft of the left femur following a fall. Solid bony union in good position was obtained following closed reduction and immobilization in plaster. The patient returned to work on May 16, 1943. At that time muscle examination showed fair power in the hip muscles, no power in the muscles about the knee except a trace in the hamstring muscles and no power below the knee except a trace in the flexors of the toes. The foot was held in equinovarus. The right lower extremity was ½ inch shorter than the left. Due to difficulty in walking and deformity of the left foot the patient was admitted to the hospital for stabilization of the foot. On June 23, 1944, a triple arthrodesis was done. On January 3, 1945, an arthrodesis of the ankle joint was performed. The foot was placed in 15 degrees equinus. Weight-bearing in plaster was permitted two months postoperatively. Three months postoperatively roentgenograms showed evidence of bony union and weight-bearing in a shoe with a ¾ inch sole and 1½ inch heel lifts was begun. One year postoperatively the patient was walking without a brace or support and had no complaints.

CASE VI. A fifty-four year old, white male with complaint of pain and stiffness in the left ankle gave a history of having had the foot run over by a loaded wagon twenty years before, with resultant pain and stiffness becoming worse in the last five years. Dorsiflexion was limited to 90 degrees and enlargement of the lateral malleolus was noted. Walking was limited by pain, stiffness and weakness. On September 29, 1943, ankle and subastragalar

fusions were done. The wound broke down postoperatively but responded to conservative therapy. A walking plaster was applied twelve weeks postoperatively and weight-bearing with no immobilization was started fifteen weeks postoperatively. Follow-up of one year found the patient symptom-free and walking four or five hours daily without complaint.

CASE IX. A thirty-four year old, white male had a gunshot wound of the lower third of the right tibia and the right ankle which he suffered December 23, 1943. The compound comminuted fracture had been treated elsewhere. When admitted July 6, 1944, the leg and foot were edematous, several draining sinuses were present and the patient had not borne weight. Roentgen examination showed fragmentation of the lower end of the tibia and fibula and numerous lead shots. There was marked demineralization of the bones. On October 18, 1944, an ankle fusion was performed. Penicillin was given pre- and postoperatively. A walking plaster was applied in two months and three and a half months postoperatively he was walking in a shoe. One year after surgery he complained of occasional pain when walking on rough ground. No evidence of activity of the osteomyelitic process was found.

SUMMARY

1. Bony fusion was obtained in nine of the ten patients including those with tuberculosis and osteomyelitis. One operation for correction of paralytic deformity resulted in failure of fusion after six months' immobilization. However, the functional result is satisfactory as the corrected position is being maintained.

2. Cosmetic improvement was obtained in all of the cases. This was most marked in the cases of paralytic deformity in which stabilization of the flail foot resulted in a more normal appearance. The thickening and discoloration of the skin associated with an underlying arthritis were no longer present in the patients with traumatic arthritis. The two patients with chronic infection complicated by draining sinuses obtained bony fusion and healing of their sinuses.

3. Functional use of the foot was improved in all ten cases. The patients presenting paralytic deformities found this particularly true. Increased stability of the ankle joint meant either wearing a smaller type of brace or completely discarding it. The patients with traumatic arthritis who formerly were limited to walking short distances now were able to carry on their normal activities without difficulty.

CRYPTOMENORRHEA*

CONGENITAL AND ACQUIRED

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CRYPTOMENORRHEA will occur whenever an obstruction exists in the genital tract below a functional endometrium or a pathologic process that causes bleeding. The obstruction may be congenital or acquired, complete or incomplete. The endometrium may menstruate in response to normal stimuli or the bleeding may be secondarily induced by estrogens.

Retention of the menses was known to the ancients but the descriptions are vague and incomplete. Ricci[1] in his researches into the history of gynecology provides the following information: Rhazes (850–923 A.D.), an Arab physician, in Book XXII of the Continens, recognized imperforate hymen for which he advised incision followed by daily coitus. Hildanus (1560–1634 A.D.) described three cases of imperforate hymen. One was in a girl of sixteen who once a month was seized with violent abdominal pains, fainting spells, headaches and occasional epileptic fits.

EMBRYOLOGY

The forms taken by the congenital types of this disease are readily understood after a consideration of the development of the genital tract. The Müllerian ducts appear as invaginations of the celomic epithelium. The lower portions of these ducts fuse in the midline and form a solid cord which tunnels caudally through the mesenchyme and impinges on the posterior wall of the urogenital sinus to form the Müllerian tubercles. The cephalic, unfused portions of these ducts become the fallopian tubes while the fused caudal portions give rise to the uterus, cervix and the greater part of the vagina. Failure to fuse at the proper level gives rise to the varieties of bicornuate uterus. Failure of fusion combined with persistence of the septum between the two ducts causes anomalies ranging from a small septum, as in the uterus subseptus, to complex anomalies such as uterus didelphys with a double vagina.[2] Arrest of the mechanism of proliferation and canalization can cause atresia at any level.

Investigators differ in their interpretation of the development of the lowermost portion of the vagina and hymen. The work of Koff[3] on the formation of the human vagina gives us a workable explanation of the later clinical findings. His investigations reveal the lower one-fifth of the vagina and the hymen to be derived from the urogenital sinus. Bilateral posterior evaginations of the urogenital sinus occur which obliterate the Müllerian tubercle. These are called sinovaginal bulbs and by proliferation of their lining epithelium and fusion they form, together with the lowermost portion of the fused Müllerian ducts, the primitive vaginal plate. The solid primitive vaginal plate grows in all directions while the central cells break down to form the lumen of the vagina. The hymen is composed of a posterior segment and anterior paired segments. The posterior segment is seen to arise from a bulbous expansion of the primitive vaginal plate. The anterior paired segments are formed from bilateral lips at the point of origin of the sinovaginal bulbs.

Imperforate hymen may be interpreted as occurring because of excessive proliferation and coalescence of the epithelium of the sinovaginal bulbs. Congenital retro-

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hymenal atresia probably arises from non-canalization of the lowermost end of the fused Müllerian ducts.

ETIOLOGY

Cases of congenital origin provide the greater part of those reported in the literature. Table 1 is not statistically significant and only indicates the fact that the rare type of case is reported in the literature. Common congenital types are imperforate hymen and congenital retrohymenal atresia. The distinction between these two anomalies is difficult but may often be made by location and histologic study of the occluding membrane. A hymen has stratified squamous epithelium on both sides. Patches of Müllerian duct epithelium may be recognized on the inner surface of a membrane which is a true retrohymenal atresia, while the subepithelial layers contain muscle fibers, many blood vessels and lymphocytes.[4] Atresia of the vagina is a common cause although collectively more cases involving complex uterine anomalies have been recorded. Lateral hematocolpos and lateral hematometra are seen if a blind side exists in one or another type of didelphic or bicornuate uterus.[5,6,7]

TABLE 1
ETIOLOGY OF CONGENITAL CRYPTOMENORRHEA

	Literature 1926–1946	Present Study	Total
Imperforate hymen	142	12	154
Congenital retrohymenal atresia	29	1	30
Congenital atresia of the vagina	26	2	28
Uterus bicornis unicollis, blind rudimentary horn	16	..	16
Uterus didelphys, double vagina, unilateral blind vagina	13	1	14
Uterus bicornis unicollis, unilateral blind horn	5	..	5
Uterus septus duplex, blind hemi-uterus	5	..	5
Uterus didelphys, rudimentary blind horns, gynatresia	2	..	2
Uterus bicornis septus, unilateral blind horn	2	..	2
Uterus bicornis duplex, unilateral blind vagina	2	..	2
Congenital atresia of the cervix	2	..	2
Total	244	16	260

TABLE II
ETIOLOGY OF ACQUIRED CRYPTOMENORRHEA

	Literature 1926–1946	Present Study	Total
Agglutination of the labia minora	1	..	1
Vaginal Atresia Subsequent to:			
Laceration during childbirth	2	..	2
Non-specific adhesive vaginitis	2	..	2
Traumatic laceration of the vagina	..	1	1
Senile vaginitis	1	..	1
Gonorrheal vulvovaginitis	1	..	1
Burns from actual cautery	1	..	1
Syphilis of the vagina	1	..	1
Repair of high vesicovaginal fistula	1	..	1
Carcinoma of the vagina	1	..	1
Cervical Atresia Subsequent to:			
Cervical fibromyoma	6	1	7
Trachelorrhaphy	4	1	5
Intracervical radium	4	1	5
Laceration during childbirth	4	..	4
Dilatation and curettage	3	..	3
Senile atresia	3	..	3
Cauterization of cervix	2	..	2
Fibrosarcoma of the uterus	2	..	2
Postabortal endometritis	2	..	2
Chronic endocervicitis	2	..	2
Cervical stricture, cause unknown	2	..	2
Missed abortion	1	..	1
Total	46	4	50

1. The cases in the present study include those indexed over a fifteen-year period (1932–1947) in the Woman's Clinic of New York Hospital and the Woman's Hospital in the State of New York. One case is a private patient of Dr. W. E. Studdiford and one a patient of Dr. Byron Goff, New York, N. Y.

2. We wish to thank Dr. Albert H. Aldridge for making the records of the Woman's Hospital in the State of New York available to us in this study.

The acquired disease results from some agent which causes occlusion of the cervix or stricture of the vagina. (Table II.) Infection caused by or following in the wake of the primary etiologic agent is an important factor. Agents destroying the epithelial lining of the vagina with subsequent adhesions between granulating surfaces cause some cases. Operative procedures on

the cervix and the use of heavy cautery tips may cause subsequent contracture of the cervical canal. Atresias of the cervix may cause retention of menstrual blood when castration has not been complete after improperly screened radium. As an indirect result of pregnancy, cases have been seen after abortion, missed abortion and lacerations of the cervix or vagina. Fibromyomas mechanically obstruct the cervical canal and are a common acquired cause. Atrophic changes which occlude the lower genital tract or cervix before the complete cessation of menstruation or subsequently induced estrogen bleeding will result in a retention of blood. In a rare case the labia minor were completely agglutinated from a vulvitis in childhood.

Cryptomenorrhea actually is a complication of some other lesion of the genital tract. A clearer picture of its frequency and etiology is seen from its occurrence over a one-year period in a large gynecologic service. During 1948 there were 1,966 admissions on the gynecologic pavilions of the Woman's Clinic of New York Hospital. During that year eleven cases of acquired hematometra were seen but no congenital cases. The acquired cases complicated the following diseases: carcinoma of the fundus, four; cervical myoma, three; after intracervical radium, two; carcinoma of the ovary, one; senile atresia of the cervix with estrogen induced bleeding, one.

The twenty cases in the present study, listed in Tables I and II, also show that the rare congenital lesions are recorded while the cases of acquired cryptomenorrhea have been indexed under primary disease only. Twelve cases of imperforate hymen were encountered, one of congenital retrohymenal atresia, two of congenital atresia of the vagina and one case in a uterus didelphys. The four cases of the acquired disease by no means indicate the true incidence, but Table II does give a rather comprehensive list of underlying lesions seen with this complication. Two cases are described in more detail:

CASE I. A fourteen year old white female complained chiefly of recurrent attacks of lower abdominal pain of seven months' duration. With each attack she experienced nausea, vomiting, dysuria, low sacral backache and constipation. She had never menstruated externally. Her past history revealed that at the age of three years the patient had fallen astride her crib with resultant laceration of the vagina and vaginal hemorrhage followed by a persistant purulent discharge. Vaginal examination revealed a thick, white, scarred septum 3 cm. above the hymen. There was a cystic fluctuant mass filling the pelvis. The uterus could be made out on top and to the right of the distended vagina. A combined abdominoperineal approach was used at operation. Two hundred fifty cc. of old blood were drained from the uterus and vagina, the septum excised and a right salpingectomy done for a badly involved tube with hematosalpinx. Her periods became regular and two subsequent vaginal plastics were done for cicatricial stenosis of the vagina at the ages of seventeen and twenty-three. She has subsequently had two full term pregnancies with deliveries by cesarean section.

CASE II. A sixteen year old colored female had had a steady stabbing pain in the lower abdomen every twenty-eight days for four years. She had never menstruated externally. There was periodic swelling of the lower abdomen and ankles. For six years she had had stress incontinence on laughing or sneezing. Enuresis had existed all her life. On examination there was a small rudimentary vagina with a common opening for urethra and vagina. The uterus and adnexa were not definitely outlined. Cytoscopy revealed the right half of the trigone to be absent. The bladder was of small capacity. An intravenous pyelogram showed a silent right kidney and a left pelvic kidney with irregular calyces. Exploration and dilatation of the blind vaginal vault resulted in the drainage of 90 cc. of old menstrual blood. She now has scant periods every twenty-eight days with relief of symptoms.

PATHOLOGY

Where the obstruction exists at the outlet as in congenital retrohymenal atresia and imperforate hymen, the onset of menstruation initiates a sequence of events that may ultimately involve the entire genital

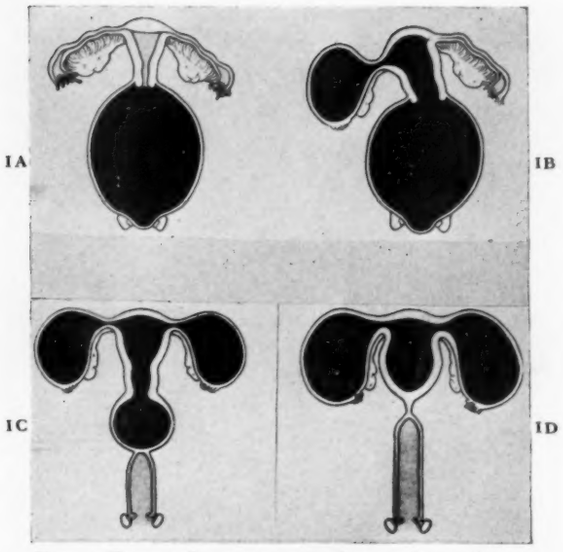

FIG. 1. Types of cryptomenorrhea; A, imperforate hymen, hematocolpos; B, imperforate hymen, hematocolpometra, right hematosalpinx; C, congenital atresia of vagina, hematocolpometra, bilateral hematosalpinx; D, congenital atresia of cervix, hematometra; bilateral hematosalpinx.

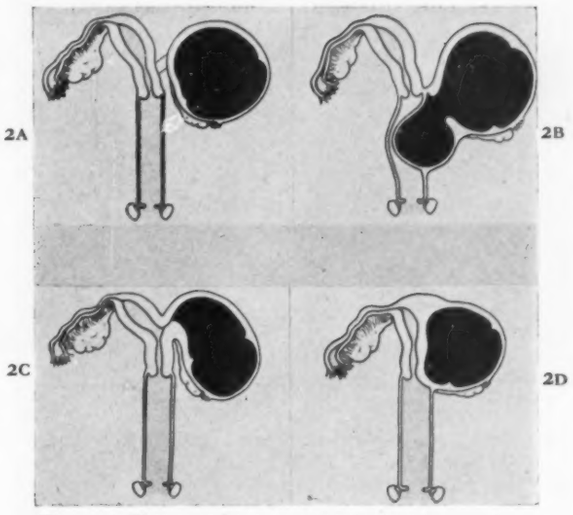

FIG. 2. Types of cryptomenorrhea; A, uterus bicornis unicollis, lateral hematometra in blind rudimentary horn; B, uterus didelphys, lateral hematocolpometra due to blind left vagina; C, uterus bicornis unicollis, lateral hematometra in blind left horn; D, uterus septus duplex, lateral hematometra in blind left uterine cavity.

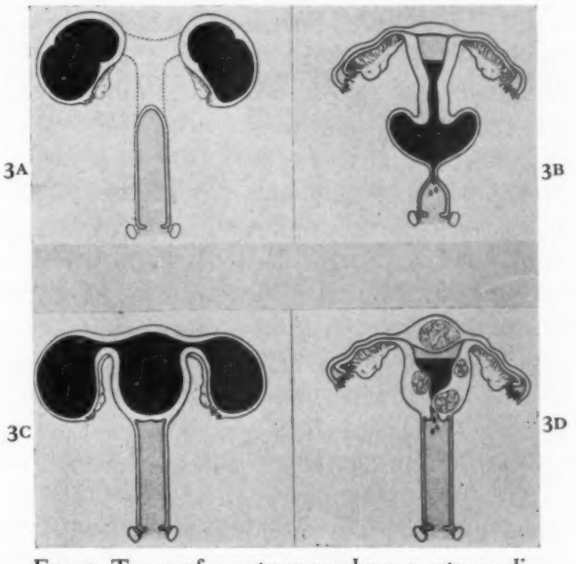

FIG. 3. Types of cryptomenorrhea; A, uterus didelphys, two rudimentary horns, hematometra due to gynatresia; B, acquired atresia of vagina, intermittent hematocolpometra; C, acquired atresia of cervix, hematometra, bilateral hematosalpinx; D, cervical fibromyoma, intermittent hematometra.

tract. Prior to the menarche the secretions of the cervical, uterine and tubal glands form a hydrocolpometra which may be insignificant in size or contain an appreciable amount of fluid. To this is now added the periodic menstrual flow. Fortunately, the vagina is very distensible and will hold a large amount of fluid before the retrograde distention fills and distorts the upper more vulnerable and permanently damaged uterus, tubes and ovaries. (Fig. 1A.) The contractile powers of the uterus spare this organ until late in the disease and in the moderately advanced cases the walls show hypertrophy due to the expulsion of the menstrual flow against positive pressure.[7] A laparotomy now would reveal the uterus perched on the dome of the hematocolpos.[8] The tubes, ovaries and cervix now succumb. The isthmic portions of one or both tubes may seal off; but if not, menstrual blood is forced into the tubes causing a hematosalpinx, on the peritoneum causing a hematoperitoneum, and about the ovary resulting in a hematovarium. Local reaction on the peritoneum seals the fimbriated ends of the tubes which expand and involve the surrounding structures in a tubo-ovarian tar cyst. The cervix effaces and dilates causing a hematotrachelos. The uterus dilates and its walls become thinner and the glands compressed. (Fig. 1B.) Secretions and menstrual flow become less as the glands throughout the tract become atrophic and functionless. The process would be self-limited were it not symp-

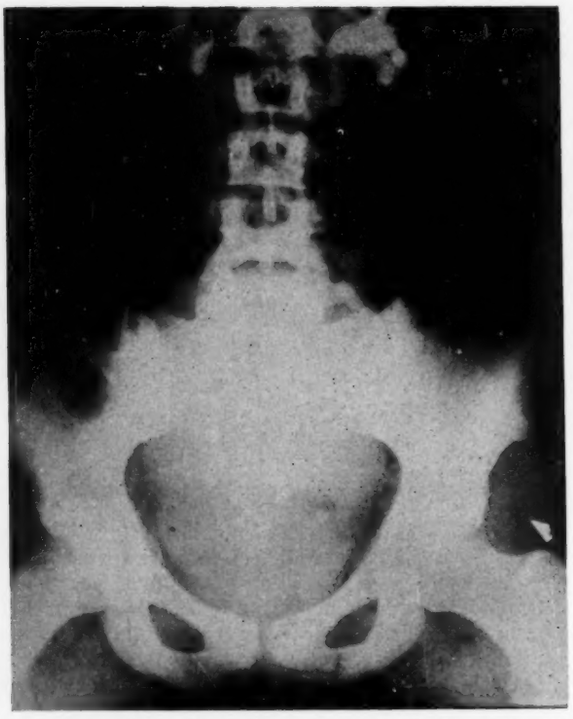

FIG. 4. Bilateral hydroureter and hydronephrosis caused by a large hematocolpos.

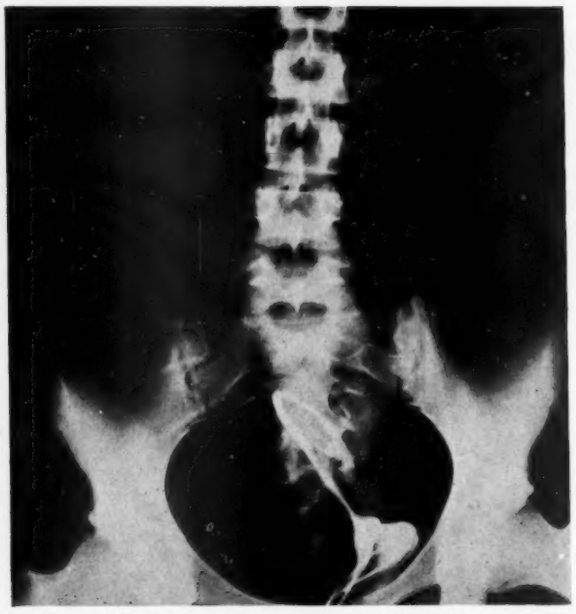

FIG. 5. Left pelvic kidney with a silent kidney on the right; absence of the urethra and right half of the trigone of the bladder; congenital atresia of the vagina with a small hematocolpos.

tomatic long before reaching such an advanced state.

Where an obstruction exists at a higher level, multiple abnormalities of the genital tract are common. Above a vaginal or cervical atresia or in the blind horn of a bicornuate uterus, a functioning endometrium will menstruate and make exceedingly bizarre findings.[9] Not infrequently one uterus and vagina of a didelphic uterus is blind. Figures 1, 2 and 3 show several diagrams representing forms of the disease.

The acquired cases rarely obtain the large size of the congenital types since the disease is treated earlier and the level of obstruction is higher. (Fig. 3B,C,D.) The process becomes a pyohematocolpos or pyohematometra when partial obstruction allows an ascending infection from the vagina.[10] An intermittent hematometra or hematocolpos exists when an obstruction such as a cervical fibroid gives way periodically and drains.

COMPLICATIONS

The urinary tract is so commonly involved in this disease that urologic studies should be done in each case. In low obstructions the expanding pelvic lesion may elevate and compress the bladder. With further increase in size of the hematocolpos, the ureters are spread wider apart as they course through the pelvis and the angle at which they enter the bladder is more obtuse. The pressure soon becomes sufficient to cause hydroureter and hydronephrosis. (Fig. 4.) The urethra may be compressed against the symphysis in addition to being angulated at the bladder neck. Complete obstruction can take place with enormous dilatation of the bladder. In high obstruction concomitant anomalies of the urinary tract are frequent. Duplication and malformation in the course of the ureters, ectopic kidney, bladder anomalies and the absence and duplication of the urethra have been reported.[12] (Fig. 5.) It is important in each case to demonstrate by cystoscopy and urography the course, number and relationships of the ureters.

The membranes seen in imperforate hymen and retrohymenal atresia are thick and tough and obviate spontaneous rupture. (Fig. 6.) Diverticulum formation or rupture into the rectum, bladder or ischio-

rectal fossa is possible.[13] Spontaneous amputation and rupture of a dilated blind horn is reported. Rupture of a large hematosalpinx with hemorrhage causes an abdominal catastrophe.

COMPOSITION OF RETAINED BLOOD

The composition and quantity of the retained blood depends on the duration of the disease and on the presence or absence of infection. As much as 3 L. have been drained in some instances. In the uninfected cases the retained blood is thick and dark, having the appearance of chocolate syrup. The longer the duration of the disease the more viscid are the retained products of secretion and menstruation due to the resorption of the liquid elements. In cases of short duration the cervical, uterine and tubal glands provide a proportionately larger part of the fluid. As the process becomes older and the tension within the vagina and uterus becomes greater, the glands of the cervix, uterus and tubes are compressed; and although they are recognizable histologically, it is unlikely they contribute an appreciable amount to the contents.

Histologically, the solid elements are red blood cells in all stages of disintegration, many living leukocytes and cast off cells of the uterus and vagina.[14] Mucin and pigments can be demonstrated. Lactic acid is present in large enough quantities to make the fluid acid to litmus. Specific determinations of the calcium and iron show them to be higher than in whole blood. An analysis of the fluid from one of our cases revealed the following values: non-protein nitrogen, 29; uric acid, 4.3; urea nitrogen, 17.8; chlorides, 11; sugar, 8; calcium, 9.4; total proteins, 5.9 and a pH of 7.5.

Cultures of the fluid are sterile in the congenital cases in which no drainage to the exterior has ever been effected. The cases with partial obstruction or recurrent hematometra are frequently infected and here the retained blood is more liquid, foul-smelling and often frankly purulent. Because of repeated replacement and drainage there is little difference from menstrual blood but with the added factor of infection. Infection is present during the development of strictures in the acquired types of the disease whether it be the primary etiologic agent or not. Once sealed off the cavities may become sterile, as acquired cases of long duration are seen draining only retained blood and no pus.

FIG. 6. Imperforate hymen, hematocolpos.

SYMPTOMATOLOGY

Periodic pelvic pain, failure to menstruate and dysuria form a triad of symptoms suggesting an expanding pelvic lesion, such as hematocolpos, from obstruction at the outlet. The failure of the menarche to appear is not the most common primary complaint that brings the patient to the doctor as many mothers just consider their daughters late.[16] Occasionally the urinary symptoms dominate the picture and are the primary complaint. The pain due to vaginal distention is a dull ache in the perineum and sacrum which is increased by sitting and defecation. Painful hemorrhoids may exist from pressure on the rectum. Menstrual molimina often recur at monthly intervals associated with nausea, vomiting and vertigo. At cyclic intervals an acute hypogastric pain, as in severe dysmenorrhea, may be added. Acute lower abdominal pain, as in pelvic peritonitis, suggests a hematoperitoneum.

Dysuria is the most common urinary complaint. With increasing obstruction the patient may complain of frequency and the stream becomes progressively smaller and

less forceful. Abdominal pressure may be used to start the flow. An attack of complete retention first brings the patient to the physician in a surprising number of cases. With the development of a hydronephrosis, flank pain may be a symptom.

In cases of high obstruction of congenital origin, no set pattern of complaints is discernible. Primary amenorrhea, vague pelvic pain, attempts at coitus in cases of vaginal atresia, urinary complaints, dysmenorrhea in cases of lateral hematocolpometra, sterility or the appearance of an abdominal swelling prompt these patients to seek medical advice. The symptom complex in a given case depends on the extent, duration and location of the expanding lesion.

The patients with acquired lesions are seen early because they have usually been under treatment for a pelvic complaint prior to the development of an obstructive lesion. Secondary amenorrhea, pelvic pain or intermittent passage of old blood and pus are the common complaints. The urinary tract is not involved as a rule and does not give rise to symptoms. Patients frequently date the onset of the process and suggest the cause.

DIAGNOSIS

With a large hematocolpometra from obstruction at the outlet a tender suprapubic mass can be palpated. This mass frequently rises to the umbilicus or above. An imperforate hymen spreads the labia minora and presents a bulging, dusky membrane. (Fig. 6.) An impulse created by percussion of the abdominal tumor is transmitted to the hymen and perineum. This abdominoperineal fluid wave is, in our experience, pathognomonic of a large hematocolpos. Coughing also produces an impulse on the bulging membrane. Rectal examination reveals the distended, tense vagina filling the pelvis. Following aspiration the thickness of the occluding membrane can be roughly estimated by palpation between the rectal and external finger. On combined recto-abdominal examination an outline of the pelvic organs may be obtained. It is of primary importance to determine the extent of involvement of the uterus and tubes. With the vagina alone involved, the uterus may at times be felt sitting on the dome of the distended vagina. With advanced adnexal involvement, boggy, painful masses may be felt in one or both adnexal regions.

The membrane of retrohymenal atresia may frequently be distinguished from an imperforate hymen on gross inspection. The former is thinner and the hymen itself may often be seen exterior to and stretched on the anterior perimeter of a bulging retrohymenal membrane.

Palpation and inspection will disclose atresias of the vagina and cervix with a pelvic mass above. A bulging mass can be felt on the affected side of the vagina with a lateral hematocolpos. Under strictly aseptic conditions an exploratory needle may be passed into the fluctuant mass and the characteristic fluid withdrawn. The latter may now be replaced with an equal amount of radiopaque media and x-rays taken to give further information on the anomaly.[17]

Acquired atresias are seen in the upper one-third of the vagina. Probing may reveal a partial atresia and allow the escape of blood and pus. Acquired cervical atresias that are complete present a bulging, fluctuant tumor of the vaginal vault. The cervix is effaced and careful inspection reveals a dimple or linear depression at the location of the external os. The exploring needle should enter at this point. Where partial obstruction exists, probing will usually reveal the nature of the disease.

So few cases are seen by anyone that mistaken diagnoses are common. A careful pelvic examination, if necessary under anesthesia, will reveal the true nature of the obscure case. The amenorrhea and a pelvic mass frequently leads to a diagnosis of ovarian neoplasm. Appendicitis and ruptured ectopic pregnancy can be closely simulated by a hematoperitoneum. The symptom complex of recurrent monthly pelvic pain together with amenorrhea will alert one to the possibility of hidden men-

struation and prompt a search for a source of obstruction or the presence of genital anomalies.

TREATMENT

The treatment of imperforate hymen and retrohymenal atresia is identical. The patient is prepared for both perineal and abdominal operations and a recto-abdominal examination under anesthesia is performed to determine if a hematosalpinx exists. If no adnexal involvement is evident at this examination, a few cubic centimeters of old blood are aspirated by needle and syringe to confirm the diagnosis. Further procedures are deferred until the following day as it is desirable to have the patient awake for the hymenotomy. Local anesthesia is used in order that the patient may report any signs of intraperitoneal hemorrhage from an undetected small hematosalpinx. A cruciate incision is made in the membrane, the quadrants excised and the edges approximated with sutures of fine catgut.[18,19] This prevents future closure or rigidity of the hypertrophic membrane. Suprapubic pressure is not used to hasten drainage nor is the cervix visualized at this time. The prophylactic use of antimicrobials is recommended prior to operation and for several days postoperatively until the profuse drainage of old blood ceases. Irrigation of the vagina or the use of drains can only be condemned as inviting infection. The patient is placed in Fowler's position and can be mobilized early if her course is normal. Frequent vaginal examinations are avoided until after the first menstrual period unless indicated earlier by persistence of symptoms or other developments. Involution of the tract requires several months and the first few menstrual periods may be abnormal. No douches, coitus or swimming should be allowed until involution is complete. The genital tract is studied by low pressure uterosalpingograms using a small quantity of contrast material several months postoperatively. Residual damage and tubal patency are determined.

The examination under anesthesia may reveal adnexal involvement. In this event laparotomy is performed prior to hymenotomy in order to observe the drainage abdominally. The dangers of an intra-abdominal hemorrhage are very real. The sudden release of pressure with contraction of the uterus can tear adherent tubes away from the pelvic wall or rupture vascular adhesions.[20] All bleeding is controlled and only hopelessly diseased organs removed. The tubes are milked of old blood and the adhesions at the fimbriated ends are gently separated. While many tubes might empty spontaneously,[21] it is not believed that expectant treatment is indicated in cases with a hematosalpinx.

Atresias of the vagina and cervix are explored from below and a canal created from the apex of the blind vaginal vault to the lower pole of the pelvic mass. An assistant's finger in the rectum and a sound in the bladder serve as guides. The combined approach is indicated when exploration from below is unsuccessful or the pyelograms indicate an anomaly of the ureters in the field of operation. A hysterotomy is performed, the old blood evacuated and the anomalous ureters visualized. A finger is then placed in the cervix or lower pole of the uterus and used as a guide for an assistant to dissect on from below. Alternately dissection may be done from above on the assistant's finger below. The newly formed canal is kept open by insertion of glass dilators or a formed balsa wood plug beginning in the early postoperative period.

Lateral hematocolpos is treated by complete excision of the septum between the blind and patent vaginas if such anomaly exists. Simple incision should not be done as secondary closure is common. A laparotomy is performed for the anomalies that do not lend themselves to vaginal drainage. A hemi-hysterectomy, excision of an atretic horn or rarely a hysterectomy may be indicated.

Treatment of acquired cryptomenorrhea involves the re-establishment of the con-

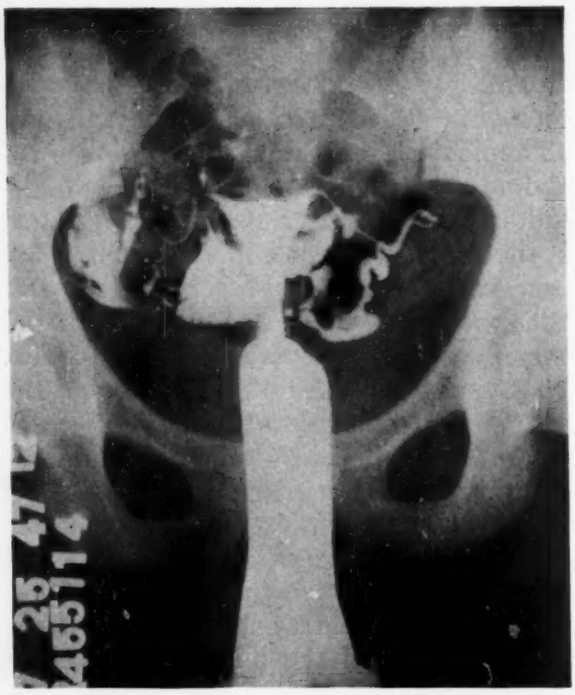

FIG. 7. Normal uterus and patent tubes ten months after drainage of a large hematocolpos.

tinuity of the vagina or cervix and subsequent measures to insure patency. The dissection is easier than the congenital types as the relationships of the bladder and rectum are normal. Infection will respond to adequate drainage but is resistant to treatment if partial obstruction remains. The denuded areas of the vaginal cases are separated daily while healing. The cervix is dilated as often as necessary to assure a patent canal. Rarely a modified Pozzi operation is needed to evert the external os. Further surgical procedures, indicated because of the etiologic agent, are preferably deferred until the infection is controlled.

Patients with congenital cryptomenorrhea require special guidance to prevent the normal psychic trauma of the menarche from becoming pathologic. The anxiety connected with the onset of menstruation is exaggerated when the adolescent girl finds her menstrual function is abnormal.[22] The patients with uncomplicated hematocolpos should be reassured and given an adequate explanation of the amenorrhea. Should pregnancy fantasies exist these are dispelled. As optimistic a prognosis as is compatible with the findings should be given regarding menstruation and reproduction.

Those patients with abnormalities having a poor prognosis may react acutely to the discovery of an anomaly. The questions of marriage, sexual compatibility and sterility will arouse marked anxiety in a young woman normally much concerned with these events. The tendency to devaluate herself after becoming aware of her affliction may cause serious conflicts. A profound neurotic disturbance may threaten, requiring prolonged psychotherapy for which a psychiatric consultant should be sought.

PROGNOSIS

The uncomplicated hematocolpos is cured by hymenotomy with return of the genital and urinary tracts to normal. (Fig. 7.) Menstrual difficulties are usually not seen after the first few periods and the urinary tract suffers no permanent damage. Later pregnancies have been regularly reported when the disease has been confined to the vagina. The prognosis is not good when a large bilateral hematosalpinx is found as the salpinges suffer permanent damage. Many cases reported as sterile in later life had some form of irrigation or packing used in the treatment.

Individual prognostication, based on the structures that can be spared at operation, must be made in the case of the various anomalies. The anomalies of duplication with unilateral involvement lend themselves to operations that spare some healthy ovarian and endometrial elements. In general, the prognosis here is good regarding the relief of symptoms but poor in regards to pregnancy. The acquired disease responds favorably when the infection is controlled. Recurrences must be guarded against by periodic examinations.

CONCLUSIONS

1. Occlusion of the genital tract is infrequent despite the vast amount of surgery and cauterization that is performed.

2. The urinary tract is involved so frequently in these diseases, either because of concomitant anomalies or because of comqression by the pelvic mass, that urologic studies and follow-up should be done in each case.

3. The use of prophylactic penicillin and sulfadiazine reduces the risk of infection and improves the prognosis regarding tubal patency.

4. The combined abdominoperineal approach should be used when the tubes are involved or when anomalies of the ureters make them liable to injury during any operative procedures from below.

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TECHNIC OF PRESACRAL NEURECTOMY

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THE resection of the pelvic sympathetic plexus, which I did for the first time in 1925 as a treatment of dysmenorrhea, is already accepted in all countries of the world. Since 1925 I have extended the indications of this resection to the treatment of vaginismus, pelvic neuralgias, resistant vulvar itch and some cases of genital superexcitement. However, if one judges the articles published on that subject, the results are not always as they are expected to be; some surgeons claim that only 50 of 100 patients have been cured.

Personally, in over 1,500 patients seen in a period of twenty-two years I count only 2 per cent who were not cured by the operation. These patients are classified as having dysmenorrhea caused by a psychic or a physical defect which this operation could not improve.

If we closely analyze the articles published by some surgeons with regard to their lack of success in that operation, we can say without hesitation that their results are the consequence of a defective technic.

In our first operations, which gave us good results, we looked on the presacral lamina for some nervous strings the way anatomists taught us. In 1926 we reported that it was necessary to do a radical resection of all the fibro-cells of the lamina in which the elements of the superior hypogastric plexus lay and which contained more or less important nerve cells and numerous ganglionic tissues.

Several times we heard from foreign surgeons that they had never done such radical operations as the ones we did in their presence. Afterward, using our technic in this operation, those surgeons had good results which were comparable to ours.

TECHNIC

Technic being the important question for good results, it is important for us to give all the details:

1. *Anesthesia.* Spinal anesthesia, 12 or 15 mg. of novocain, is our preference. It produces good abdominal relaxation and, the patient being in Trendelenburg position, it is easy to reach the promontory.

2. *Incision of the Abdominal Wall.* Very often we do a low Pfannenstiel incision so that the cutaneous scar will be hidden by the pubic hair. This incision, however, needs careful control of bleeding.

The abdominal aponeurosis must be incised at least 3 or 4 cm. higher than the cutaneous incision. Otherwise it would be difficult to reach the body of the fifth lumbar vertebra in front of which one must find the presacral nerve.

3. *Intraperitoneal Maneuvers.* At first one must closely examine the internal genitalia in case any lesion is present which could be so small as to be overlooked by a clinical examination before operation. One may discover slightly diseased ovaries or little foci of endometriosis or adenomyomatosis of the cornua, etc. It is almost always possible to treat such small lesions by conservative operations if one does the resection of the presacral nerve afterward. Sometimes these lesions are sufficient to explain the dysmenorrhea and, even if their excision would cure those patients, I have always insisted that one do the resection of the presacral nerve in cases of dysmenorrhea because most often these lesions of the genitalia are not included in the pathology of menstrual pains.

4. *Resection of the Pelvic Sympathetic.* It is on the body of the fifth lumbar vertebra slightly above the promontory that the nerve is the most easily accessible.

It is important to see the promontory very well for it is *the first anatomic point to remember*. Above and slightly outside of the promontory the two primary iliac arteries, which are lying immediately under the peritoneum, form a triangle with an inferior base and the apex is formed by the division of the aorta. This forms *the second anatomic point to remember*. In this area, which will be more visible if one reclines the pelvic colon, one will see, a little outside of the middle line at the left, the inferior mesenteric artery which runs in the mesocolon near its insertion line.

We always cut the peritoneum vertically. This permits us to make a longer incision up and down if we decide to do a more or less important resection of the pelvic sympathetic. (Fig. 1.) Generally we are satisfied with an incision 4 to 5 cm. long, the middle of which should correspond to the promontory. Retracting the two lips of the peritoneal incision, one can see forward to the spine a cellulofibrous mass which covers the body of the vertebra. In this cellulofibrous mass the pelvic sympathetic lies (superior hypogastric plexus of Hovelacque). (Fig. 2.)

To perform a good resection of that plexus it is important before cutting it to dissect the presacral lamina cleanly on its sides. To do this, either with the tip of long scissors or with a dissector of Leriche, one has to separate the edges of that fibrous lamina. (Fig. 3.) Anteriorly the lamina has been separated from the peritoneum already. On its edges this lamina is mixed with subperitoneal cells but on the right side it is easy to recognize the edge of the fibrous lamina in which the sympathetic nerve lies. The posterior part of the lamina is also easy to separate. Usually the medium sacral vessels remain adherent to the skeleton. On the left side the mesenteric vessels may be troublesome but one has to be careful not to injure them.

In certain cases the primary root of the mesocolon has its insertion on the median line making it more difficult to reach the promontory. If this condition exists, we always make our incision of the posterior peritoneum 1 cm. outside the median line. Retracting the left lip of that peritoneal incision, we push aside the mesenteric vessels and usually the anterior part of the presacral lamina is easy to dissect.

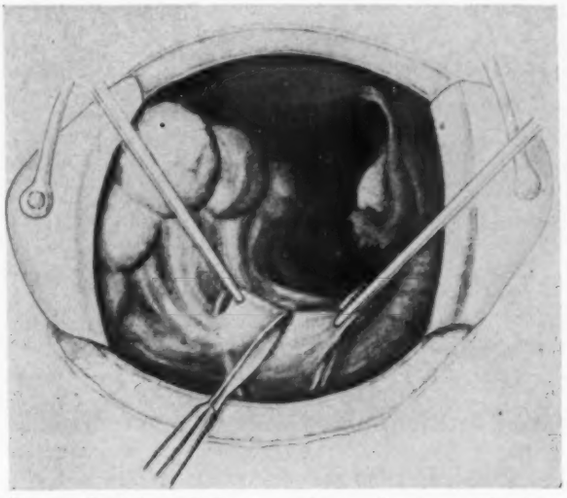

FIG. 1. Incision of the posterior peritoneum lifted up in front of the fifth lumbar vertebra.

To have a better dissection of the fibrous lamina in which the nerves lie, we use as a rule the Deschamps needle which is introduced in the hole made on the right side. This needle is used to dissect the left side by pushing away the mesenteric vessels. (Fig. 4.)

If we lift up the presacral lamina with a Deschamps needle at the level of the fifth lumbar vertebra, we see that it becomes wider as it passes the promontory and then takes a triangular form with its apex up. (Fig. 5.) This is the cross section of the presacral nerve from which the two hypogastric nerves proceed to the two corresponding ganglions (inferior hypogastric plexus of Hovelacque).

The nerve being lifted up, it is easy to finish its dissection upward and downward. Before cutting it is very important to be sure that the whole nerve will be cut and not just one of its branches right or left. For this reason it is very important to see the angle of the cross section where the presacral nerve gives birth to the hypogastric nerves. If only one of the two nerve cords is seen, the reason is that only half

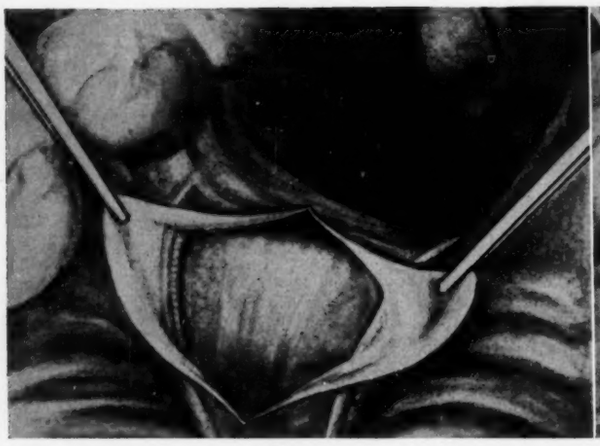

FIG. 2

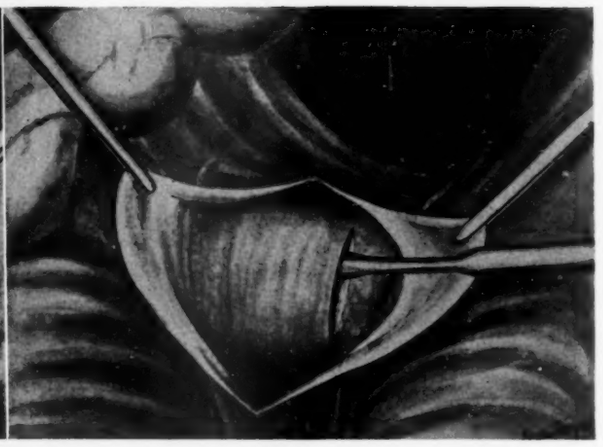

FIG. 3

FIG. 2. Retraction of the peritoneum to give a clear view of the presacral lamina; on the left are the mesenteric vessels in the base of the mesosalpinx; on the right is the ureter after crossing the hypogastric vessels.
FIG. 3. Separation of the presacral lamina on its right side.

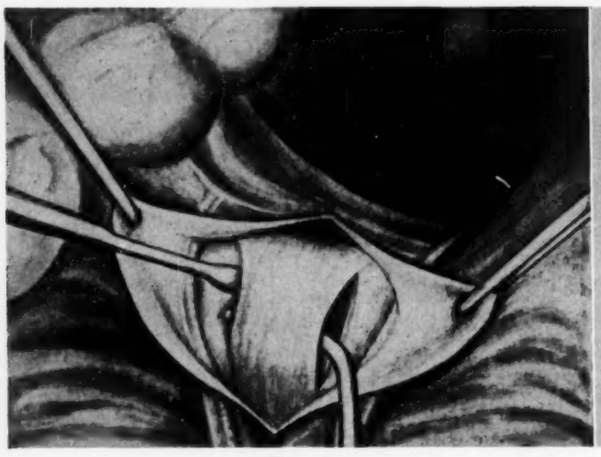

FIG. 4

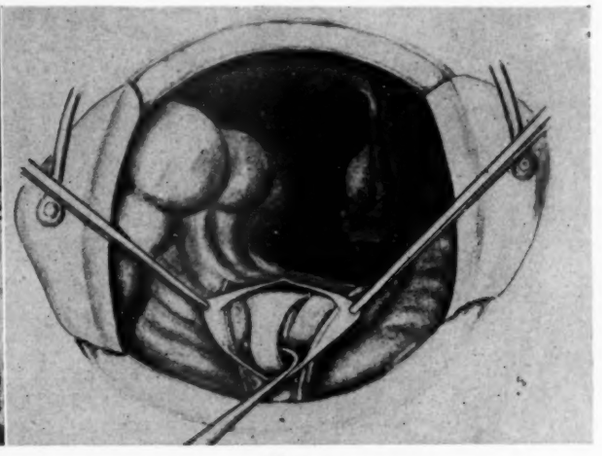

FIG. 5

FIG. 4. Separation of the presacral lamina is performed with a "Deschamps needle" and a dissector.
FIG. 5. The entire lamina is lifted up with a curved, smooth-edged needle before being widely resected. Note the triangular shape formed by the hypogastric nerves which prolong it.

of the presacral nerve lies on the needle. Then it is important to find and dissect the other half. It is very useful to have at your disposal two Deschamps needles, one right-handed and one left-handed. Before cutting the lamina with a soft instrument such as the handle of a Deschamps needle, we break the few afferent branches which come from the two last lumbar ganglions or the first sacral ganglion.

Usually we cut a length of 2 to 4 cm. of the nerve. The lamina in which the nerve lies contains only small blood vessels (vasa vasorum). Therefore, it is useless to tie both ends. We even think that tying the lamina is a cause of pain. If there is slight bleeding, pressure for a while on the lamina along the spine will control it. The use of electrocautery to cut the presacral lamina will prevent this bleeding.

The left primary iliac vein is behind the sectioned lamina. It is almost always a little higher than the point where the presacral lamina is liberated practically where there is no danger of hurting it. The ureters are more outside. If the surgeon is on the left side, it is very easy to localize the right ureter. Only once did we accidentally hurt the left ureter which was very near the insertion of the pelvic mesocolon. This had not been dissected properly.

The nerve being cut, we suture the posterior parietal peritoneum. The latter is so loose that it may be closed with a purse string suture.

If the uterus is movable and, even more if it is retroverted, we complete the operation by fixing the ligaments using the method of Doleris-Gilliam-Pellanda. It is done to prevent scar retraction of the uterosacral ligaments and a secondary retractile parametritis in case there would be a slight serosanguineous exudate.

5. *Closure of the Abdominal Wall.* This procedure offers nothing in particular. However, it has to be done very carefully so that the anatomic reconstruction will be as perfect as possible.

6. *Postoperative Results.* There is usually no incident. We have never noted any immediate disturbances which were due to the sympathectomy. There is no urine retention and micturition is often much easier after than before the operation.

In over 1,500 operations we never saw any major accident. In only two cases was there slight bleeding of the posterior peritoneum on the first postoperative day so we had to re-operate and repair the posterior peritoneum. In two other cases there was an infiltration of blood in the subperitoneal tissues which infiltrated in the posterior region of the rectum but was spontaneously absorbed. Before closing the posterior peritoneum, one must be sure of perfect control of bleeding. It is to be noted that these patients need three or four injections of morphia on the first day on account of their postoperative pains. Phlebitis and pulmonary infarcts are rare and do not exceed 1 per cent, due to the fact that the patients are young and free from any visceral diseases.

We have never noted any later disturbances among our patients. There were numerous women who had one or more absolutely normal pregnancies afterward. Women suffering from dyspareunia now have normal coition. We never saw a case of frigidity following the operation.

Symptoms may recur but that has been the exception; we count only 2 per cent of them. In all cases the symptoms existing with dysmenorrhea, namely, fever, vomiting, intestinal cramps, etc., clear up simultaneously.

We did the first resection of the presacral nerve twenty-three years ago and we can definitely affirm that, until now, no other method of treating dysmenorrhea has given such consistent good results.

RECENT EXPERIENCES WITH THE CORKSCREW BOLT IN FRACTURES OF THE HIP*

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ALMOST ten years have elapsed since the report of our early experiences with the corkscrew bolt.[1] Many difficulties had been encountered with the manufacture of the instrument and with its technical application and these problems were stressed in that early report. It was the general impression at that time, in spite of Kellogg Speed's warning, that the fractured hip problem had been solved quite adequately by a wide variety of instruments. New devices and technics seemed unnecessary and interest in the corkscrew bolt's development lagged accordingly.

The broadened experience of subsequent years with all types of internal fixation failed to support our complacency. Although even the most recent statistics are at a wide variance, almost all agree that the proportion of unsatisfactory results continues high and that slipping and nonunion play a significant role in the failures. Many operations have been designed for the relief of ununited hips. For their prophylaxis, however, only the current practice of many surgeons of prohibiting all weight-bearing until x-rays show evidence of bony healing has evolved. It is hardly necessary to point out how costly in time and how poorly tolerated this practice can be for the elderly patient. The prolonged inactivity it entails is a common cause of rapid and irreversible mental and physical deterioration.

Dissatisfaction with our results as well as those of others prompted us some four years ago to restudy completely the nonunion problem with specific reference to compression-fixation, a principle which held our confidence. The failures of others that had come to our attention as well as our own failures were carefully reviewed and the corkscrew bolt and its application again was subjected to careful analysis. The present report is based upon this study and the encouraging application of its result in the therapy of our subsequent intracapsular fractures.

NON-UNION

The quest for a solution of the problem of non-union of the hip entails, first, a clear concept of what is required of hip fixation. For reasons that are not obscure, the intracapsular hip fracture presents more obstacles to healing than any other common fracture. Aside from its unique vascular properties, to be discussed later, the lesion from the outset is bathed continually and on all sides in joint fluid so that fracture hematoma is washed away as soon as it is formed. Fractures in this area also possess the unique misfortune of being directly antagonized by both muscle pull and weight-bearing. These forces, instead of aiding to keep the fracture ends against each other, pull crosswise, almost parallel with the plane of the fracture, and develop a shearing rather than compression stress as Pauels has emphasized.[2]

When the power of these forces is sufficient to overcome the fixation strength, the fragments move with reference to each other and, as the head sinks, the verticality of the fracture plane is increased. This further compromises the opportunity to heal. Still more motion pulls the fracture surfaces past each other so that even contact is lost. Because of the consistent

* Read before the Orthopedic Section of the New York Academy of Medicine on March 19, 1948.

direction of this position slip, a hip fracture can be safely termed ununited quite early at a stage when most fractures would be properly considered as the site merely of delayed union.

Counteracting these tangential forces and in precarious equilibrium with them is the fracture fixation, the efficiency of which is quite variable and the result of several components. Important variables include accuracy of the specific reduction, accuracy of the instrument insertion and, of even greater importance, the strength and texture of the fractured bone.

Even the efficacy of the fixative instrument cannot be regarded as constant since its grip varies widely with the porosity of the bone through which it is inserted. Although most hip fractures occur in bone that is the site of some osteoporosis, its degree is subject to marked individual variation.

To be recognized also is the fact that *all* fixative devices are interval supports only. Even when perfectly applied through strong bone, none is capable of holding indefinitely. They are able to hold only until the reasonably prompt takeover of reparative tissue. If this fails to develop with normal speed, weakening of the fixation, rarification and slipping are prone to occur. It is necessary, therefore, to add the time dimension to the aforementioned static elements, the factors which are known to delay healing although they do not weaken the primary fixation.

Postoperative Hip Fracture Equilibrium

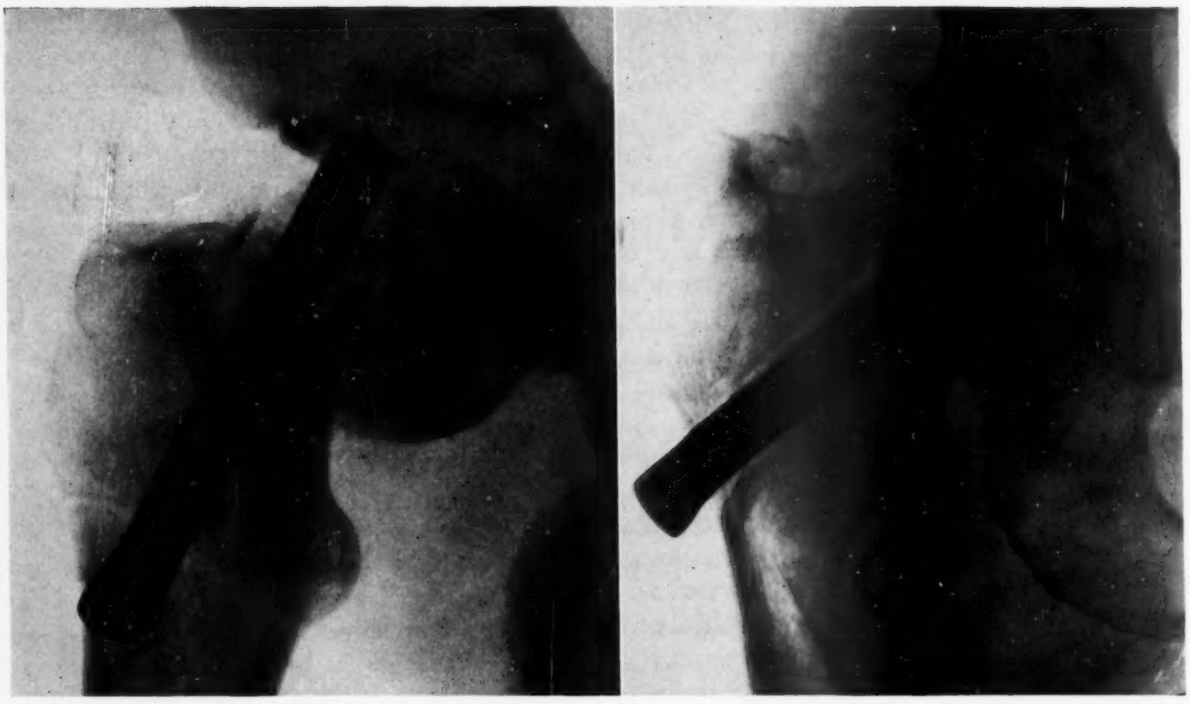
↓ Muscle Pull
↓ Weight Bearing

↑ Efficiency of Fixation Instrument
↑ Reduction and Fixation Accuracy
↑ Bone Sturdiness
↑ The Time Factor

Ample experience supports the belief that healing will practically always follow fixation with standard instruments properly executed and through solid, healthy bone. Conversely, there is evidence that *the margin of safety is small* and that deviation from accuracy in the controllable factors is promptly reflected in the results. Excellence in one variable can compensate in some measure for deficiency in another. Firm fixation through strong bone, for example, can overcome the weakness of imperfect reduction and the opposite is also true. Failure in more than one factor courts disaster. According to these criteria it is not difficult to determine with some accuracy where the basic defect lies in almost all instances of non-union whenever adequate post-reduction films are available. During the past few years thirty-two cases of non-union were so classified (patients who came to us following initial treatment elsewhere, who were seen in consultation and patients following our own unsuccessful therapy). The results of this classification are exhibited in Table 1. The first column in Table 1 represents an enumeration of the conditions which weaken the primary fixation but do not delay healing. In the middle column are the conditions which weaken the primary fixation and also cause healing delay. In the third column are the conditions which do not cause weakening of the initial fixative strength but which cause healing delay. Reparative tissue in these

TABLE 1

Non-union Mechanical Weakness	Delayed Healing	No. Cases
A. Instrument		
1. Poor reduction or application		5
2. Extrusion of nail, wandering		1
3. Diastasis		1
B. Host		
1. Fracture obliquity (early)		?
2. Excessive muscle pull (spasticity, etc.)		1
3. Paget's, metastasis, etc		
4. Osteoporosis		
	a. Post-menopausal	12
	b. Senile	
	c. Secondary to invalidism	1
	d. Dietary	
	5. Total aseptic necrosis	9
	6. Circulatory insufficiency	2
	7. Fracture line obliquity (late)	All
	8. Diastasis (late)	All
	Total	32



IA IB

FIG. 1. Two types of slipping; A, early, generally reflecting poor insertion; B, common slip due to failure of mid-cervical bone.

conditions can be so slow in developing that it fails to take hold before the initial fixation deteriorates to the point of slipping.

It is important to note the high proportion of failures that presented no clear evidence of aseptic necrosis. If the instances of non-union herewith classified represent a fair cross section of those generally encountered and if our reasoning has been correct about the reciprocal relationship of the fixation factors, a large proportion of non-unions might be avoided by firmer fixation. A firmer bond at the fracture site can overcome the defect in material or workmanship. It might hold firmly enough to tide over until the reinforcement of healing tissue has developed.

MECHANISM

The actual mechanism of the fracture slip shows very little variation in these separate categories. If the nail is used, it may buckle out of the head. This mishap in our experience generally occurs in the early postoperative period and reflects inadequate or improper insertion. The majority of slips later during convalescence occur with the capital fragment securely fastened to the instrument in their original relationship and with this entire unit displaced downward with reference to the distal fragment. (Fig. 1.) Such slips are due to the weak bony structure of the femoral neck of the distal fragment close to the site of the fracture (Ward's triangle) and its inability to buttress the immobilizing device adequately. (Fig. 2.) The poorly trabeculated spongiosa of this area projects the main support of the nail to far below the fracture site and close to its point of insertion in the cortex. The strain upon this remote support is magnified greatly in accordance with the laws of leverage, often approaching precarious limits. The critical point is exceeded when the decalcification of sustained fracture hyperemia is added to any of the aforementioned basic defects. The capital fragment and pin slide backward and downward until a vertical fracture line is produced which virtually precludes further healing.

In the anatomic laboratory this weakness is not difficult to demonstrate. The ease is surprising with which apparently firm fracture fixations with a wide variety of instruments can be broken up by relatively slight force applied to the distal extremity in the direction of external rotation. Once the fixation gives ever so slightly in this plane, solidarity in other planes develops prompt weakness and it becomes easy to push the head into varus position. It is reasonable to assume that the greater part of our clinical failures to maintain alignment originates in such a primary posterior slip.

In the laboratory only one maneuver mitigated against this weak point, firm impaction. By impaction I do not mean merely close contact of the fracture surfaces but actual intrusion of ¼ inch or so of neck into the substance of the head. When such impaction is obtained by proper application of the corkscrew bolt, the force of external rotation may be increased until the round ligament finally ruptures and the head dislocates anteriorly. The integrity of the fracture fixation remains undisturbed. This experiment serves to emphasize that the corkscrew bolt presents no material advantages over other devices in the maintenance of normal opposition of the fracture surfaces. Its function is the production and maintenance of real impaction; and only when this is attained, does the bolt provide a stronger bond than other fixation instruments. When it is properly used to produce impaction, the strength of the fixation is considerably greater than that of any other device tested.

It is my belief that impaction also yields more rapid healing than simple apposition but this rests entirely on clinical evidence and is not amenable to simple laboratory verification.

HISTORY

A number of surgeons have interested themselves in compression mechanisms for greater security in hip fractures. To my knowledge Henry[3] was the first to experiment along these lines. His device, described in 1934, did not appear practical for several reasons, chief among them being the inadequate hold on the femoral head. (Fig. 3.) It is my belief that the corkscrew

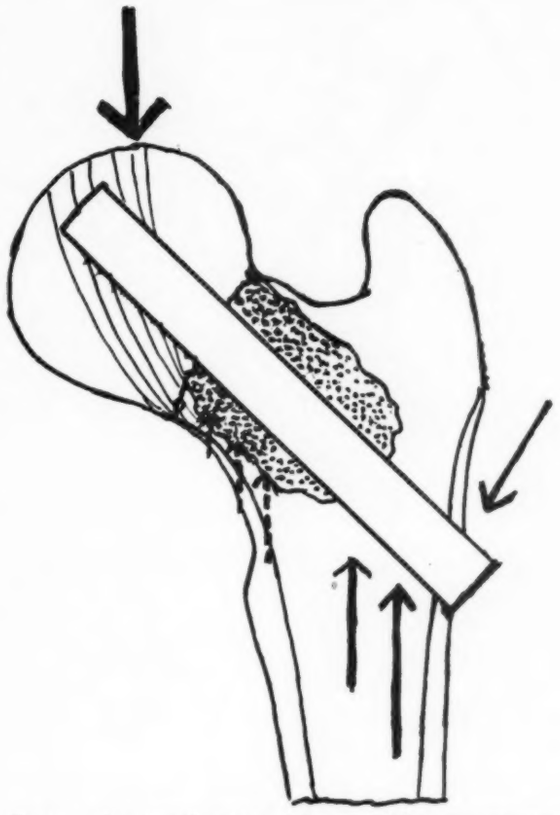


FIG. 2. The distribution of forces with non-compression instruments; illustrating the precarious support of the mid-cervical bone. This is overcome by compression and impaction.

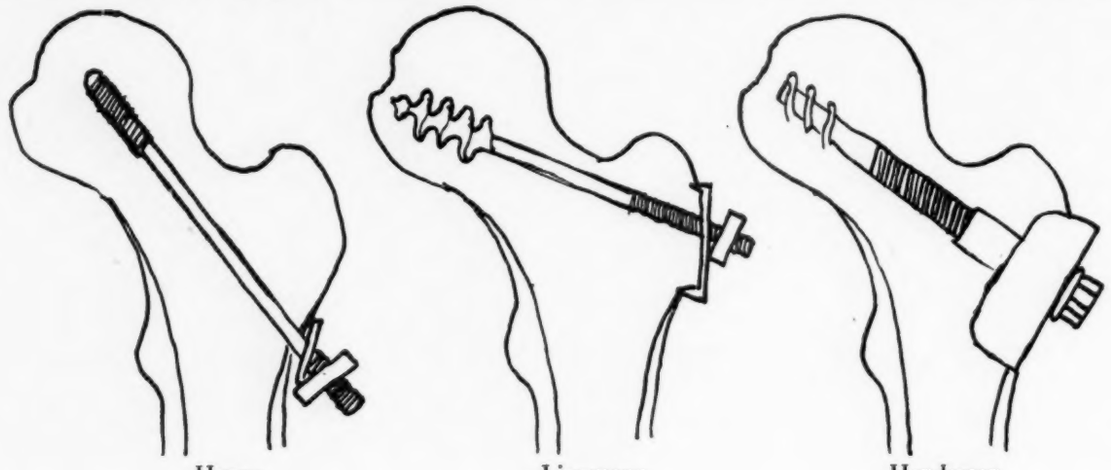
bolt described in 1936[4] was the first practical instrument utilizing the compression principle. (Fig. 3.) Except for the change of metal from steel to Vitallium, it has been used essentially unmodified in our institution since its original description and is the instrument employed in the cases herewith presented.

Various instruments made for a similar purpose have appeared in subsequent literature, the most important of them being those of Henderson,[5] Putti,[6] Godoy-Moriera[7] and Virgin.[8] (Fig. 3.) The efficiency of these instruments varies considerably and it is doubtful whether any

of them represent any noteworthy improvement over the corkscrew bolt. This is because a corkscrew bolt provides the greatest pull for an instrument of its size. A corkscrew has no central core or shank. It is much easier to make an instrument with a solid core because it can be turned on the lathe while a corkscrew must be twisted. To supply equal power, moreover, its over-all diameter must be greater than that of the corkscrew. A smaller over-all diameter but equal power means less bone destruction, easier placement and less force tending to rotate the femoral head out of position during insertion.

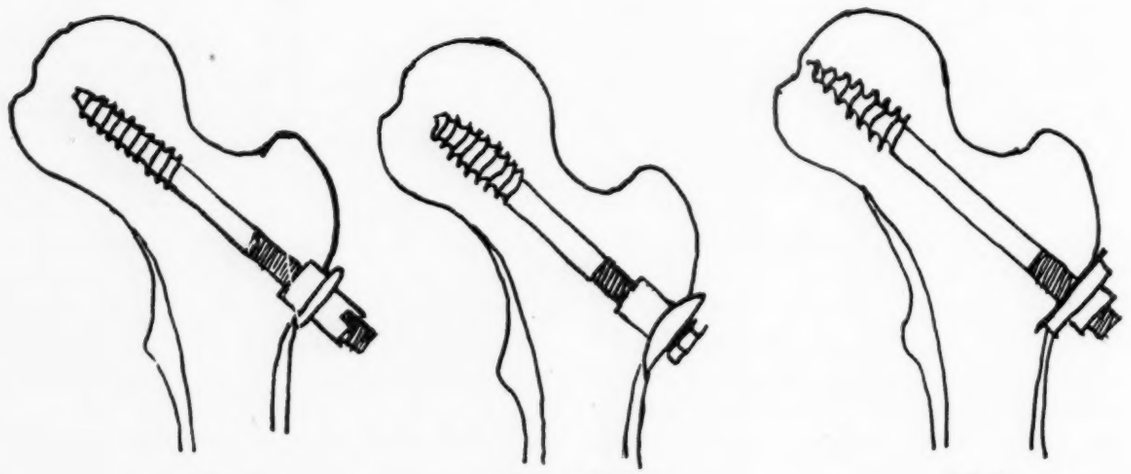
Another advantage of the corkscrew not encountered in its successors is the simple trochanter catch which locks it securely against rotation after insertion. If revolution of the entire bolt complex should occur after its insertion, even to the extent of half a turn, immediate loss of compression force and impaction would naturally result. There are a number of less important conveniences of the corkscrew bolt that I have not presented, namely, it cuts its own thread and the excess shaft may be cut off easily, so dispensing with the need of any measurements and assortment of sizes.

The Virgin traction screw is larger but not otherwise dissimilar to the corkscrew



Henry 1934 — Lippmann 1936 — Henderson 1937

FIG. 3A



Putti 1938 — Godoy-Moriera 1940 — Virgin 1945

FIG. 3B

FIG. 3. A and B, various devices used for compression of hip fractures.

bolt and it should function well. (Fig. 3.) Recently Virgin and MacAusland[8] have added a coiled take-up spring below the nut but I am not certain whether or not this represents an improvement. In the absence of neck absorption it does not function except as a lock washer. If neck absorption should develop, the expanded elastic spring would appear to provide a very precarious and unstable fixation at best. In our experience neck absorption has proven to be an extremely rare source of difficulty occurring essentially as a sequal to motion at the fracture site and due, in turn, to inadequate primary fixation.

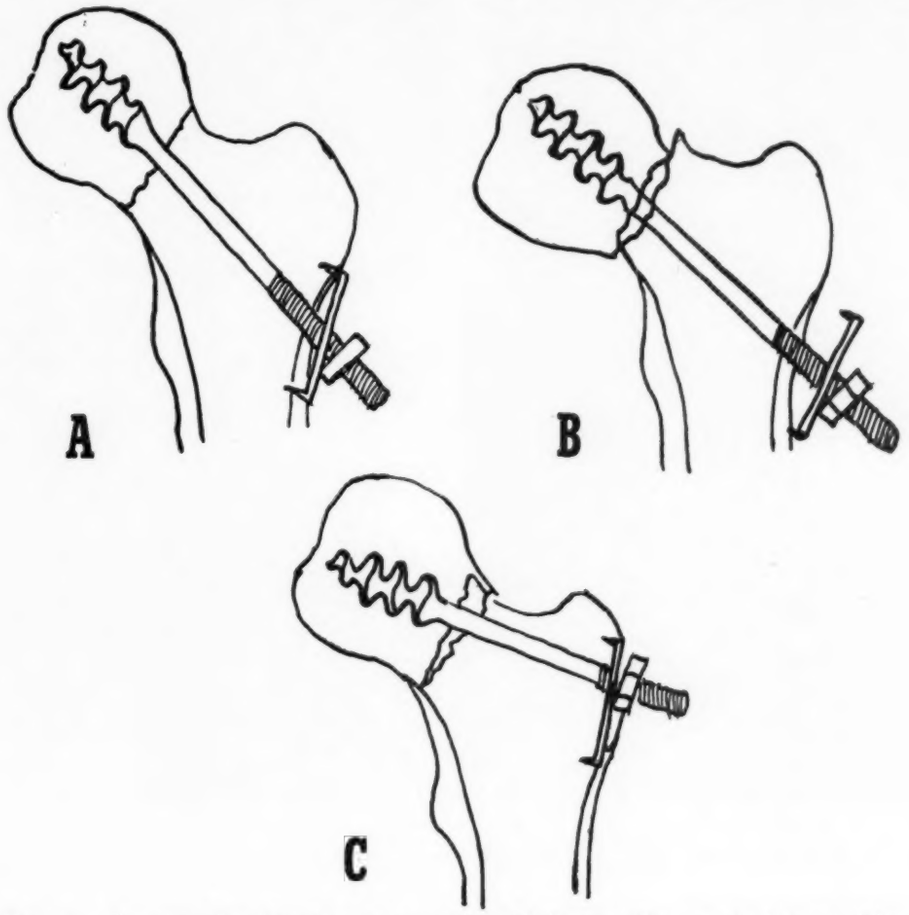


FIG. 4. A, improper low insertion; note angle with fracture line; B, the hazard of low insertion; C, the proper insertion and the valgus compression it produces.

APPLICATION

In the foregoing I have tried to indicate the error of pigeon-holing intracapsular fractures and of providing the same therapeutic approach for all of them. For consistently good results it is necessary to liberate oneself from the dogma of standardized treatment as we have learned to do with other fractures. When the bone is thin, when there are indications that healing will be slow or when reduction or fixation have not materialized as well as planned, firmer fixation may be sufficient to overcome these handicaps. Two or even three bolts can be utilized freely for this purpose. The use of an extra instrument has proved to be such a simple procedure that it is used by us almost routinely. The double bolt method owes its simplicity to the fact that there is no need of penetrating the dead center of the head. An eccentric position is compensated for by merely directing the second bolt into the opposite

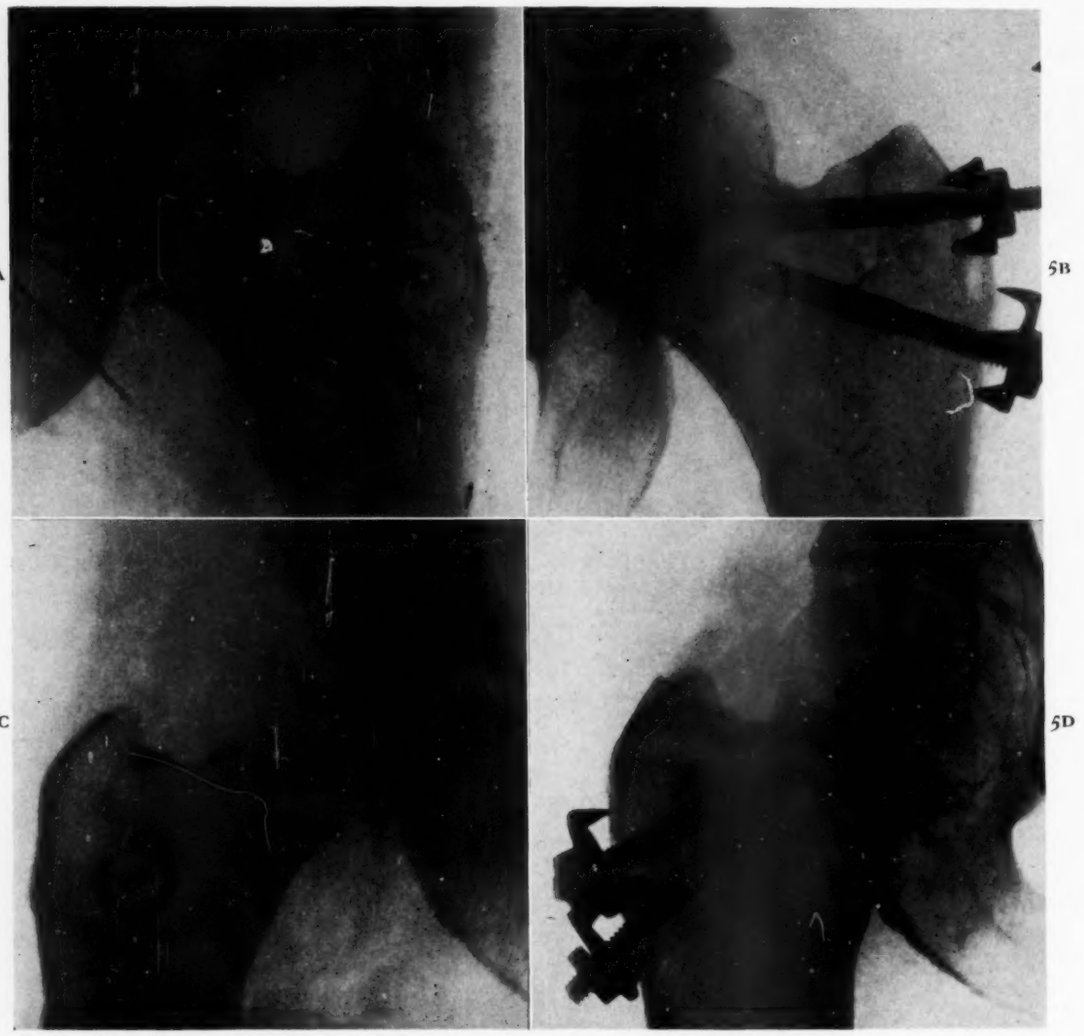


FIG. 5. Two illustrative instances of compression on the operating table. Note the comparable rotation of the shaft in pre- and post-fixation films; A and B, Case I; C and D, Case II.

head quadrant; the proper angulation of this bolt is easily accomplished without the help of any directing mechanism.

Perhaps the most important difference between the application of the corkscrew bolt and other devices is the election of a high insertion point. If two bolts are used, at least one of them must be inserted above the vastus ridge and the other not far below it. (Fig. 4.) From this point the instrument skirts the superior border of the neck to enter the head at approximately its center or just below it. With insertion above the vastus ridge, any tendency for the head to displace during compression will be into valgus and safe position. A lower cortical insertion can and often has produced satisfactory impaction but it presents the hazard of pulling the head down into varus position, the position of disaster. It seems to be particularly difficult to alter the fixed pattern of low insertion, employed with other fixation devices, to conform to these criteria. In the illustrated material you will note a number of improper insertions by members of our own staff.

The high insertion point has the additional advantage of simplifying aiming because of its greater proximity to the head. This is useful as the bolt has no core and cannot be cannulated to slide over a wire. For those who prefer it, however, the wire technic can be employed and the

corkscrew bolt directed parallel to the wire at any point within a ¼ inch radius.

The compression maneuver is always initiated in the bolt with the highest point of insertion and ¼ inch of impaction demands five or six complete turns of the nut. To avoid buckling, it is best to apply these turns one or two at a time, alternating them with the second bolt while an assistant firmly holds the leg in the position of full internal rotation. Perhaps the best evidence that these maneuvers effectively produce true impaction is available in the comparison of pre- and post-compression films taken on the operating table. (Fig. 5.)

POSTOPERATIVE CARE

After operation the question of when to begin weight-bearing must be decided upon in regard to the attributes of the individual patient and his hip fixation. Because of the strong grip of the corkscrew bolt, it was considered justifiable to experiment with early weight-bearing, permitting full weight-bearing in six to eight weeks in favorable cases. All but three of our patients followed this plan. Ill effects were not noted except on two patients, both of whom later proved to have complete necrosis of the capital fragment. Whether the solidity of these fixations is due to the efficiency of the corkscrew bolt or to the speedy repair which compression develops is difficult to determine. Probably both factors are operative. The two instances of slipping that occurred in the presence of totally necrotic heads are not disturbing. These fractures probably would have slipped at a later date, even without weight-bearing, and solid union, even if attained, would have gained little. It might be that the early recognition of these cases that slipping provides will prove advantageous rather than harmful.

There is little to support the contention of some that those hips predisposed to later collapse are unfavorably influenced by early weight-bearing. The fragility of the dead head does not appear until a good many months later when, as Phemister[9] has shown, the ingrowth of vascular granulation tissue reaches sizable proportions. It must be emphasized, in any event, that until our present series increases sizably, early weight-bearing must remain a purely experimental procedure.

TABLE II

Intracapsular Fractures	No. Cases
Died within 8 weeks	3
Protracted unrelated illness; could not be followed	3
Too recent for final evaluation	4
Followed 1–4 years	21
(average 1 yr. 11 mo.)	—
Total	31

TABLE III

TWENTY-ONE CASES FOLLOWED ONE TO FOUR YEARS

	No. Cases	Per Cent
Average age 68.3 years		
Average follow-up—1 yr. 11 mo.		
Non-union due to total aseptic necrosis	2	9.5
Late collapse of head due to apical necrosis	2	9.5
Arthritis of mechanical origin	1	4.8
Rehabilitation locally complete	16	76.2
Total	21	100.0

It is regrettable that the small orthopedic service of a general hospital does not yield sufficient material to justify accurate statistical analysis. My reluctance to submit a statistical study based on so few cases has yielded only for the purpose of illustrating how well the corkscrew bolt appears to be producing the benefits theoretically anticipated.

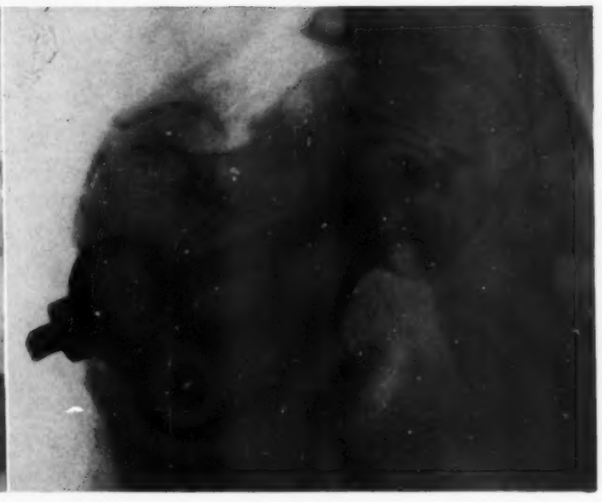
Since the institution of our present approach four years ago there have been thirty-one intracapsular unimpacted fractures of the hip subjected to internal fixation with the Vitallium corkscrew bolt. (Table II.) Three of the patients died before the expiration of eight weeks and so permitted no evaluation. Three other deaths occurred within eighteen months following operation after protracted illnesses not associated with the injury or its repair. Since these patients were invalided at remote points and were not available for

FIG. 6. Complete abeyance of arthritic changes or manifestations; A, two years; B, two and a half years; C, three years; D, one year.

control observation, they were omitted from the present report. Four patients sustained their fractures and were operated upon too recently for final evaluation. Two of these have healed and the other two appear to be healing satisfactorily. The remaining twenty-one patients have been observed for one to four years, the average duration being one year and eleven months. Of these twenty-one patients nineteen have healed with solid bony union (90.5 per cent). (Table III.) In the two patients whose fractures failed to heal proven total aseptic necrosis of the capital fragment developed; this was interpreted as the cause of failure in these instances. In the nineteen patients whose fractures healed, collapse of the head eight and ten months after fixation occurred in two, an incidence of 19 per cent of total and partial aseptic necrosis. After about the same length of time in another patient mild arthritis of the hip developed due to a screw bolt which was permitted to penetrate for this time into the joint cavity. In the sixteen remaining cases, of which Figure 6 is illustrative, there has been complete abeyance of arthritic changes or manifestations. It is recognized, of course, that such symptoms might still develop. At the present time it would seem that from the fracture standpoint these patients have been completely rehabilitated (76.2 per cent). Inasmuch as failure to heal was

7A

7B



7C

FIG. 7. A, preoperative film of a fracture slip three months after initial treatment with Moore pins; B, postoperative view with the corkscrew bolt; C, illustration of fracture site one year later.

seen only in the presence of total capital necrosis, it would appear that this rate of healing represents the maximum potential for those patients treated. As for aseptic necrosis of both varieties, the total percentage of 19 per cent is not significantly out of accord with figures obtained in other hands.

Aside from the overt arthritic changes encountered in the collapsed head instances and in the case with the protruding screw, the absence of arthritis in the remaining patients was surprising. One cannot help but wonder whether it might bear some relationship to the technic of the application of the instrument which is entirely torsional and which includes no hammering on soft bone. A process in the nature of Kümmell's disease has never been satisfactorily excluded from suspicion. In no instance was significant neck absorption or diastasis observed except after slipping had occurred in the two cases of non-union due to dead heads. With three exceptions, all of the patients in this series began full weight-bearing six to eight weeks after operation and no ill effects were noted. It may be of some interest to illustrate a few additional examples of the use of the corkscrew bolt under particularly adverse conditions.

Figure 7 represents a fractured hip of a patient who came to us almost three months after initial treatment with Moore pins elsewhere. She had not borne weight but pain of progressive severity had

caused complete invalidism. The corkscrew bolt permitted full weight-bearing six weeks after removal of the pins and secondary fixation. Firm union developed promptly. Six other late screw bolt fixations were performed in this fashion with one failure. Late insertions have been undertaken only when the head is neither dead nor so atrophied that it cannot furnish adequate support for the fixative instrument.

SUMMARY AND CONCLUSIONS

Despite the many advances in the therapy of intracapsular fractures, non-union continues common even in the presence of complete viability of the capital fragment. Thirty-two instances of non-union, representing the failures of many surgeons including our own, were analyzed with reference to the basic cause of mechanical failure in each of them. This material indicated that the reserve strength of routine fixative devices is small and suggested that it might be possible to avoid non-union in a large proportion of such cases if stronger fixation were available.

The mechanism of slipping after routine fixation was analyzed and, by cadaver experiments, it was possible to demonstrate that the corkscrew bolt properly applied provides additional strength to the fixation. Proper application of the corkscrew bolt entails the production and maintenance by the device of a firm impaction of ¼ inch, without which the instrument holds no more securely than other routine devices.

In the insertion of the corkscrew bolt, the importance of high insertion is emphasized. Insertion more than ½ inch below the vastus ridge entails the risk of pulling the capital fragment down rather than into valgus and favorable position. Since the objective is to secure maximum strength and since the porosity of the bone is very variable, it is wise to employ two corkscrew bolts instead of one, thus providing an extra margin of safety.

In the patients treated according to this plan, failures to heal have occurred only in the presence of total necrosis of the capital fragment. Since the incidence of total necrosis was low, the healing rate attained would appear to represent the maximum potential of the patients treated. The low incidence of arthritic changes in these cases appears to be in marked contrast to its frequency in other studies in which nails were used. The insertion method, torsion rather than hammering, might play a role in the avoidance of this complication. Several examples of the use of the corkscrew bolt under particularly adverse conditions are also included.

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BRACHIAL PLEXUS BLOCK ANESTHESIA

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THE purpose of this paper is to re-emphasize the value and usefulness of brachial plexus block anesthesia for surgery of the upper extremity and to present our clinical observations and impressions based on 1,100 consecutive brachial plexus blocks. Clinical findings in the comparison of 2 per cent procaine, 1.5 per cent metycaine and 6.15 per cent pontocaine as anesthetic agents for use in this type of regional anesthesia are also presented.

We were prompted to write this paper by several factors. The first is that a perusal of American literature reveals an insufficient number of articles written about this form of anesthesia. This, of course, is directly related to the fact that this form of anesthesia is not as popular nor is it used as often as it should be. Both of these conditions are present because certain misconceptions exist among some surgeons and anesthesiologists that this form of anesthesia is difficult and time consuming and that the percentage of failures is too high to warrant its use. Also that the advent of pentothal sodium has given some the impression that it is the simplest and safest agent to use in all cases including upper extremity surgery, and there is no need to "fuss about blocks." It is hoped that the presentation of our findings, with a complete review of American literature will correct these misconceptions, and encourage more anesthetists and surgeons to employ this adequate form of regional anesthesia.

Brachial plexus block, like all other regional anesthetic procedures, if successful, offers certain advantages to the patient, surgeon and anesthetist which may not be had with general anesthesia.

The physical economy of the patient is taxed the least with this type of anesthesia. Only a limited area (upper extremity) is anesthetized without disturbing the metabolism of the rest of the body. This consideration is of great importance in the poor risk patient who cannot tolerate the stress imposed by general anesthesia. Patients who present complicating conditions such as heart, renal and pulmonary diseases, chest injuries, diabetes, etc., are able to withstand surgery done with brachial block anesthesia without aggravation of the disease. It may be assumed, therefore, that nerve block is the anesthetic of choice in this type patient.

This, however, does not infer that it is to be used only in poor risk patients. On the contrary, all patients who present themselves for surgery of the upper extremity should be afforded the benefits of this form of regional anesthesia, for in addition to the above, it has the following advantages: (1) This anesthesia affects a physiologic sectioning of the nerves supplying the upper extremity with a consequent block of painful impulses which may be caused by trauma. Although Atkins[1] has attempted to show that the block will not help but rather aggravate shock, it is our impression, based on clinical experience, that patients who come to surgery in actual or impending shock improve as soon as the pain has been relieved by the block. Of course, the fluids that have been lost must be replaced. (2) Any patient who arrives at surgery with a full stomach presents no difficulties, and no danger of aspiration exists if he vomits. (3) If properly performed, it gives a minimum degree of discomfort to the patient and it allows patients who dread losing consciousness to be awake. (4) Patients with brachial blocks may be ambulatory. Out patients

may be sent home after a closed reduction of a fracture or repair of a laceration. It is also of great benefit in aged patients in whom early ambulation is necessary to prevent complications. (5) Whenever flouroscopy or x-ray is a necessary adjunct to the surgical procedure, brachial plexus block eliminates the dangers of explosions, respiratory depression or obstruction in the darkened room, and the patient is able to cooperate with the surgeon. (6) Postanesthetic nausea, vomiting and other complications such as atelectasis, shock, distention and dehydration are absent. This allows the patient to eat a regular diet and thus benefit from oral feeding. Long drawn out operations on the upper extremity such as repair of tendons and plastic procedures, if done with general anesthesia, require a comparatively large dose of drugs. These cases are sometimes followed with postoperative depression and complications which are entirely out of proportion to the operation.

The benefits derived by the surgeon are also numerous. He has perfect operating conditions. By varying the strength of the anesthetic solutions, motor power may or may not be abolished. A higher strength solution will cause muscular relaxation not attained with general anesthesia unless large doses of the latter are given or curare is used. Such relaxation is necessary in reduction of fractures and dislocations and other orthopedic procedures. If it is necessary that the patient retain some motor power in order to help the surgeon identify tendons, a weaker solution may be used. In the absence of the anesthesiologist a surgeon who is experienced in the technic may block the patient and then perform the operation. This is of great advantage in rural practices where a specialist in anesthesia is not always available.

It is advantageous for the anesthesiologist to use this type of anesthesia for it is relatively easy to learn and execute, and with a little experience it is successful in a high percentage of cases. It is cheap to administer and the equipment necessary is not bulky and can be transported easily. In unusual circumstances, when economical use of surgeons, anesthetists, and nurses is important, regional anesthesia is of great value. On many occasions during the war some of us were forced to run several operating rooms with only technicians assisting. In such instances regional anesthesia was the safest and best method. We could perform several blocks and have the technicians watch the patient. In this manner one anesthetist was able to supervise two or more operating rooms. This, of course, is not the ideal situation and should not be done unless it is absolutely necessary.

The ward nurses appreciate the use of regional anesthesia. Patients who return to the wards awake, without nausea and vomiting, and are able to help themselves immediately, relieve the nursing staff of a load which makes possible the surgical care of many more patients at one time.

The disadvantages of brachial plexus block are few. As with any other form of regional anesthesia, the anesthetist must fulfill certain prerequisites in order to obtain good results. These prerequisites are (1) a thorough knowledge of the anatomy, (2) patience and gentleness in performing the block and (3) the waiting of sufficient time (from fifteen to forty-five minutes) after the block is done before surgery is started. These are disadvantages only if the anesthetist does not observe (1) and (2) and plan for (3).

REVIEW OF AMERICAN LITERATURE

It is of interest to note that Halsted[2] was the first to realize brachial plexus block anesthesia, when in 1884 "under direct exposure he blocked the roots in the neck with cocaine solution." Crile[3] also used this method in 1897 for the disarticulation of a shoulder. In 1911 both Hirschel[25] and Kulenkampff[26] of Germany independently reported the first blind injection of the plexus through the skin, without direct exposure. These reports were followed by many others in Europe but only compara-

tively few have appeared in American literature. Although we are certain that many American doctors have employed this form of anesthesia, it is rather impressive that only a little over 1,000 cases have been reported (excluding the 1,000 German cases reported by Kulenkampff in his American article). (Table 1.)

TABLE 1
REVIEW OF THE AMERICAN LITERATURE

Note

Date	Authors	No. B.P.B.	Anesthesia Obtained			Complications
			Perfect	Partial	Fail	
1884	Halsted (quoted by Matas)[2]	N.R.	Obtained good results			None reported
1897	Crile[3]	N.R.	Obtained good results			None reported
1914	Strauchbauer[4]	8	8	0	0	None reported
1914	Neuhoff[5]	N.R.	Obtained good results			Musculospiral paresis
1915	Simpson[6]	N.R.	Obtained good results			None reported
1927	Livingston and Wertheim[7]	105	82	20	3	Transient, mild toxic reactions
1927	Labat[8]	N.R.	Obtained good results			None reported
1927–8	Hanrahan[9]	47	31	11	5	One procaine reaction
1928*	Kulenkampff and Persky[10]	1000	Obtained good results			Procaine reaction; plexus irritation
1928	Hay[11]	N.R.	Obtained good results			Vasomotor reaction; pneumothorax
1929	Strode[12]	4	4	0	0	None reported
1935	Rhone[13]	33	27	2	3	None reported
1936	Touhy[14]	N.R.	Obtained good results			None reported
1937	Tarsy and Steinbrocker[15]	81	Obtained good results			None reported
1939	Halperin[16]	28	25	3	0	None reported
1939	Miltner and Chao[17]	233	187	24	22	None reported
1939	Arnold and Gibson[18]	N.R.	Obtained good results			None reported
1943	Griswold and Woodson[19]	100	97	0	3	Two mild proc. react.; pneumothorax—2 cases
1944	Murphy[20]	45	42	0	3	None reported
1944	Phillips[21]	160	147	7	6	Pneumothorax* 3 cases
1944	Greene[22]	150	133	7	10	Pneumothorax; procaine reaction
1946	Ansbro[23]	27	27	0	0	Slight toxic reaction
1946	Damarjian[24]	100	100	0	0	Transient pneumothorax; persistent paresthesis

N.R. = Not Reported
* These are German cases reported by Kulenkampff

ANATOMY

The anatomy of the brachial plexus and its ramifications to the upper extremity are too well known to warrant any discussion. The following diagram is included only for completeness. (Fig. 1.)

However, we would like to re-emphasize that a thorough knowledge and an adequate mental picture of its anatomy are essential prerequisites for successful anesthetization of the plexus, and that the following points merit mention: (1) After emerging from between the scaleni muscles, the plexus is located rather superficially in the posterior triangle of the neck, being covered by the superficial fascia, platysma and deep fascia. (2) The three trunks converge toward the upper surface of the first rib and then pass into the axilla through its apex underneath the midportion of the clavicle. (3) Over the rib where the three trunks are grouped closely together, the subclavian artery lies immediately anterior and medial to the plexus. This vessel is also superficial and thus

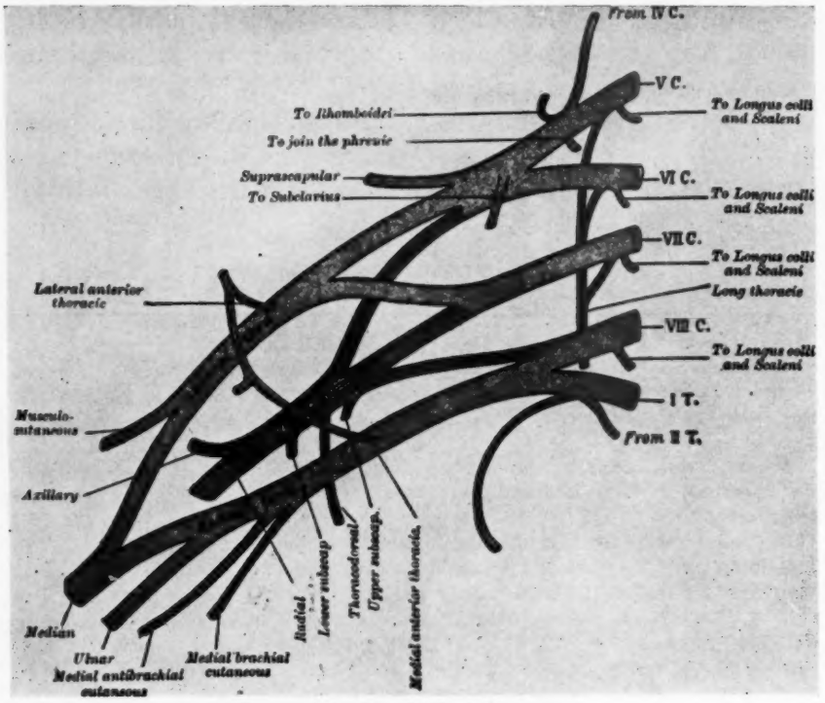

FIG. 1. The brachial plexus.

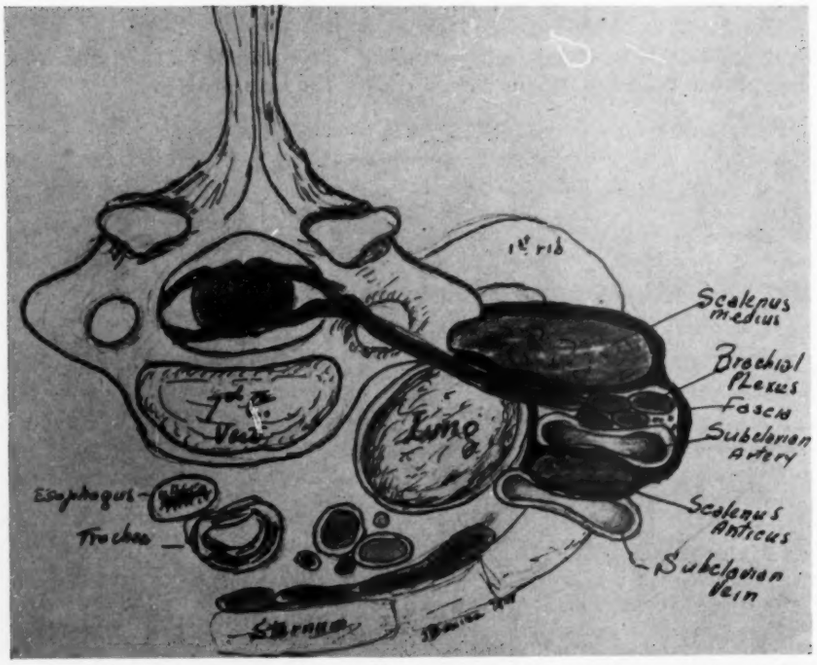

FIG. 2. Schematic cross section at the level of the seventh cervical vertebra showing the fascial compartment containing the brachial plexus and subclavian artery.

affords a palpable landmark to the plexus. (4) The fascial compartment made up of the fascia extending from the anterior and middle scaleni muscles ensheaths the plexus and artery, making possible the deposition and retention of anesthetic solutions within a relatively closed space, and thus affords the best means of anesthetizing the plexus. (Fig. 2.) (5) The first rib is an immediate deep relation which can be easily located by the needle. It acts as our most important landmark and if used properly, serves as a screen to prevent entrance of the needle into the pleura and lungs.

ANESTHETIC PROCEDURE

Preliminary Considerations. During the routine preoperative visit the anesthesia should be discussed in detail with the patient and its advantages pointed out.

Proper pre-anesthetic sedation is an absolute necessity, particularly in apprehensive patients. Many regional procedures have been called failures because the unpremedicated, apprehensive patient interpreted touch as pain and without further evaluation was immediately narcotized. We are certain that this is one of the most important factors in obtaining good results with blocks. This is particularly true in children who can be operated upon with regional procedures if indicated, provided they are sedated properly. A proper dose of the barbiturate-morphine-scopolomine combination should be given.

Whenever possible, the block should be started at least forty-five minutes before the scheduled time of operation, so that the anesthetist has sufficient time to perform the block without haste and still have at least thirty minutes between the time he finishes the block and the start of the surgical operation.

The procedure should be described to the patients, emphasizing the necessity of their cooperation for a successful block. They are instructed to snap out the word "now" when paresthesia is felt (described to them as a feeling of electricity running down to the hand or fingers).

The patient lies in the supine position with a small pillow under the upper thoracic spine allowing the neck to hyperextend and the shoulders to fall back. The head is rotated to the opposite side and the shoulders depressed caudad.

The identification of all the landmarks is done preliminary to the preparation of the skin. The subclavian artery, which is considered the most reliable landmark, is identified by palpation and the mid-point of the clavicle is also identified and marked.

Technic. Our technic of choice for brachial plexus block has been a modification of the supraclavicular approach. With aseptic conditions prevailing, a skin wheal is made 1 cm. above the clavicle just posterolateral to the subclavian artery. This usually corresponds to the mid-point of the clavicle; and in patients in whom the artery cannot be palpated, this mid-point is utilized as a landmark. The proper length needle is selected (5 cm. 22-gauge short beveled) and inserted through the wheal directing it caudad, mesiad and dorsad toward the spinous process of the third thoracic vertebra. At this point it should be emphasized that caution and gentleness on the part of the anesthetist are essential for successful results in brachial block anesthesia. Indiscriminate or careless and fast insertion of the needle may cause damage to nerves or puncture of the pleura before the operator is able to realize it. If a short beveled needle is used and is introduced slowly and gently, the operator is able to discern penetration of the deep fascia 0.5 to 1 cm. deep, denoting that the needle is within the fascial compartment which encloses the plexus. Proceeding slowly, the needle is inserted until paresthesia is obtained or until the recorder, which is placed 3 cm. from the needle point, is against the skin. If the direction of the needle is right and the patient is not fat, this is deep enough to contact the upper surface of the first rib just posterolateral to the artery. In fat individuals with a high clavicle it may be necessary to go 4 or even 5 cm. deep before the rib is touched.

Absence of paresthesia or contact with the rib at these depths denotes that not only the plexus but also the rib has been missed, with danger of piercing the pleura if the needle is introduced deeper. If the rib is contacted without paresthesia or pulsation of the needle, it has passed between the trunks of the plexus without contacting them or, more likely, the needle has been placed too far posterolaterally in an effort to avoid the artery. If paresthesia is not obtained, the needle should be withdrawn, the landmarks again checked and the needle reinserted. We feel very strongly that paresthesia should be obtained because it denotes contact with the plexus assuring us of a successful block with a quicker onset. We do not agree with some authors that it is dangerous because of possible damage to the nerve trunks, and have not observed any signs of injury following these blocks which could be attributed to this. On the other hand, we do not approve of promiscuous probing and, if after five or six careful insertions paresthesia is not obtained, one of the other technics should be used.

When the plexus is engaged, the patient senses paresthesia and, as previously instructed, snaps out the signal whereupon the needle is immobilized, aspiration is performed several times and, if no blood appears, 15 cc. of the solution is injected. During the injection the patient senses vague paresthesia due to the pressure exerted by the solution as it is being injected. This denotes the close proximity of the needle point to the plexus. After the solution has been injected the syringe is detached and the needle inserted a little farther in until its point contacts the rib. If during this procedure the patient informs the operator of *different* paresthesia, the needle is again arrested and 10 cc. more is injected. Otherwise the rib is contacted, the full syringe is again adapted and the 10 cc. of solution is injected as the needle is progressively withdrawn, depositing the last cc. of solution as the needle point emerges through the deep fascia. The needle is then reinserted through the same site and directed so that it will strike the rib surface 1 cm. nearer its sternal end. This will place it immediately posterolaterally to and in contact with the artery, a fact which is evidenced by the synchronous oscillations of the needle with the pulsation of the artery. Upon contacting the rib the syringe is adapted and 7 to 10 cc. of solution is injected as the needle is withdrawn. The third insertion through the same site is made, this time directing the needle so that it will strike the rib surface 1 cm. posterolateral to the first injection and the maneuver is repeated. If during the second or third injection different paresthesia is obtained, the needle is arrested and 5 cc. of solution is deposited. It is important to perform the aspiration test every time the needle point is moved. During injection number two the artery is sometimes pierced which is of no clinical import provided the needle is moved immediately and hematoma does not occur. By this technic the block is usually completed with 40 to 45 cc. of solution. If the tourniquet is to be used or surgery involves the arm, a subcutaneous ring is made around the upper arm in order to block the branches of the superficial cervical plexus and those of the intercostobrachial nerve. (Fig. 3.)

In the small percentage of patients in whom paresthesia is not obtained, we have used the three-needle technic suggested by Knight and described by Lundy,[27] and also have used a technic described by Patrick[28] and so well illustrated by MacIntosh and Mushin[29] in their monograph. Both of these technics aim at producing a wall of anesthesia between the skin and the rib in the area where the plexus is located. (Figs. 4 and 5.)

Many of the surgical cases have been long drawn out procedures, and in the first one hundred cases the block which was performed with 2 per cent procaine often disappeared before the surgical operation was finished. In those instances the block was repeated, but in some cases this was technically impossible because of the drap-

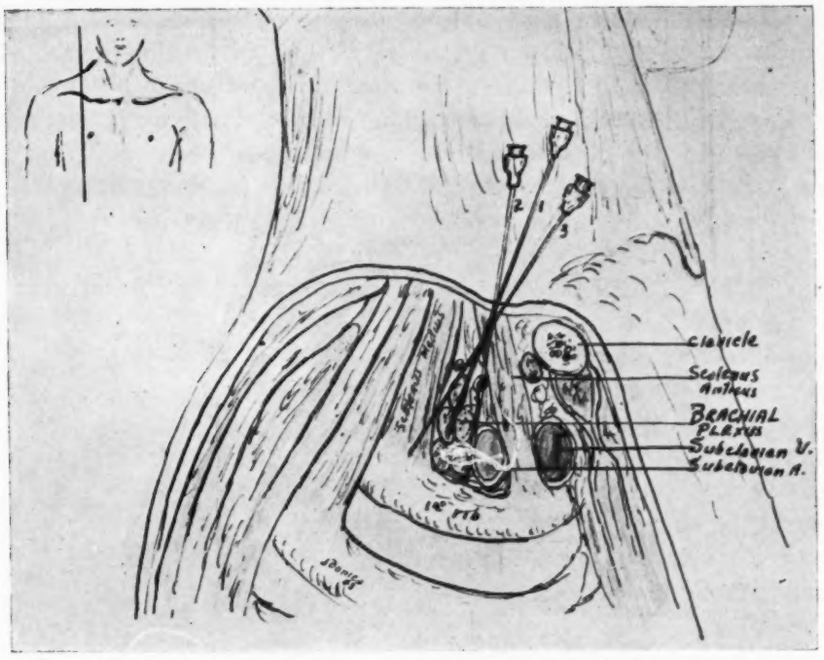

FIG. 3. Sagittal section showing a technic of blocking the brachial plexus.

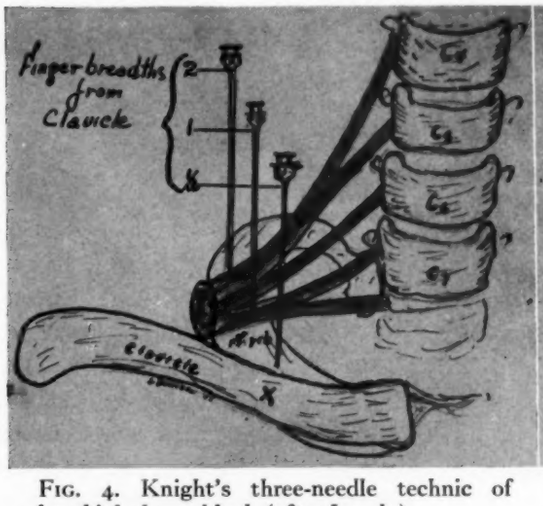

FIG. 4. Knight's three-needle technic of brachial plexus block (after Lundy).

FIG. 5. Patrick's technic of brachial plexus block.

ing or the position of the arm; consequently, we had to give the patient a general anesthesia. Confronted with this problem often enough to be annoying, we thought of a possible technic for its solution. The frequent use of the continuous spinal technic suggested the use of a similar procedure for brachial block, and on August 13, 1945, the one-hundred-first case of this series was anesthetized in almost the same manner as later described by Ansbro.[30] Some months later a continuous brachial block using a catheter in almost the same manner as used by Irving[31] for continuous caudal was then tried. In addition to the technical difficulties encountered, the results obtained were not uniform in the few cases tried with the latter method; therefore, we abandoned it, resuming the use of the malleable needle technic whenever prolonged anesthesia was needed. Since the introduction of pontocaine, however, the need for continuous brachial block has disappeared, except in rare instances whenever 1 per cent procaine must be used.

The axillary, infraclavicular and paravertebral routes were also employed in a few cases, either because the supraclavicular route was contraindicated or because we wanted to try the technic. These were found more difficult and not as satisfactory as the supraclavicular approach.

REPORT OF CASES

This paper is an analysis of 1,100 consecutive brachial plexus blocks, most of which were performed in several military orthopedic centers where we were afforded the opportunity of employing regional anesthesia for over 70 per cent of cases. All of the surgery of the upper extremity was performed with brachial plexus block anesthesia, including reduction of dislocation of the shoulder, elbow and wrist joints, reduction of all types of fractures, bone grafts, resection of bones, suturing of tendons and nerves, excision of ganglia and scars. These patients presented both acute traumatic and chronic reconstructive surgical problems involving bones, nerves, muscles and skin. A small number of the blocks were used as a therapeutic measure in arthritis of the shoulder joint, vasospastic conditions and phantom pain. A small percentage of the cases have been performed in two civilian hospitals. Consequently, both military and civilian patients have been included ranging in age from two and a half years to ninety-four years although most of them have been in the eighteen to forty year age group.

The blocks were performed by the permanent and transient members of the staff. The latter group consisted of medical officers who were assigned to one of the centers for a short course in anesthesiology given by the author. Most of these doctors had never done brachial plexus blocks before. We thus were able to evaluate the problems encountered by the novice and experienced operator in the performance of this and other regional anesthetic procedures. (Tables II and III.)

Additional Anesthesia. A number of the patients received additional complementary or supplementary anesthesia because it is believed that if for any reason patients have discomfort, it should be obviated. We emphatically condemn the performance of surgical operations with only partial anesthesia, requesting patients to withstand any discomfort or pain because "it is only going to take a few more minutes."

TABLE II
NUMBER OF BLOCKS PERFORMED BY EACH ADMINISTRATOR

Administrators	No. Cases	Perfect Anesthesia		Partial Failure		Total Failure	
		Number	Per Cent	Number	Per Cent	Number	Per Cent
J. J. B.	279	261	93.5	11	4.0	7	2.5
D. C. M.	315	292	92.7	15	4.8	8	2.5
M. O.	104	93	89.4	6	5.8	5	4.8
E. A.	100	92	92.0	4	4.0	4	4.0
H. B.	47	42	89.4	1	2.1	4	8.5
C. G.	47	44	93.6	2	4.3	1	2.1
R. S.	43	40	93.0	1	2.3	2	4.7
R. M.	39	37	94.8	1	2.6	1	2.6
E. C.	14	11	78.6	1	7.1	2	14.3
P. B. J.	21	17	81.0	4	19.0	0	0.0
J. S.	12	12	100.0	0	0.0	0	0.0
W. G.	10	8	80.0	1	10.0	1	10.0
W. B.	12	11	91.7	1	8.3	0	0.0
C. H.	9	9	100.0	0	0.0	0	0.0
C. E. H.	8	8	100.0	0	0.0	0	0.0
W. H.	5	3	60.0	0	0.0	2	40.0
Others 18	35	31	88.6	3	8.6	1	2.8
Total 34	1100	1011	91.9	51	4.6	38	3.5

Note that several students obtained perfect anesthesia in all the patients they blocked.

For reasons of clarity, additional anesthesia has been designated as complementary or supplementary depending upon the effectiveness of the brachial block. Whenever the block has been perfect and for some reason additional anesthesia had to be given, this was classed as complementary anesthesia. Supplementary anesthesia has been defined as that given as a substitute in cases of partial or complete failure of the block.

Additional complementary anesthesia as shown in Table IV has been given to patients who have had a block with a slow onset or insufficient time for onset of anesthesia. Most of the cases were planned so that at least thirty minutes elapsed between the time the block was completed and the start of surgery; but in a number of cases the time was missed, and rather

than make the surgeon wait the patient was given a short acting anesthetic such as pentothal or nitrous oxide-oxygen. This would be administered until the necessary time for the block to be effective and then the patient was allowed to react. If, after forty-five minutes the patient still had pain, they would be carried with general anesthesia for the rest of the operation and the block was classified as a failure. If, on the other hand, the patient showed no signs of pain and did not complain for the rest of the operation or for a reasonable length of time, this was considered a perfect block. In this way we have demonstrated the fact that many blocks which would have been classed as failures were completely effective. Whenever patients were apprehensive, a minimal hypnotic dose of a general anesthetic was given. On occasion, apprehensive patients who complained of pain or discomfort were given 100 mg. of pentothal or 10 mg. of morphine and they would sleep for the entire procedure. Some patients who had reactions to the drug were given pentothal plus oxygen. Whenever the block would disappear before the end of surgery, it was either repeated or a general anesthetic administered. In some patients a brachial plexus block was combined with a spinal anesthetic for bone graft operations; with superficial cervical plexus block for operations in the region of the shoulder joint; with a bracelet for surgery of the upper third of the arm; and with upper thoracic paravertebral block for operations around the scapula with excellent results.

TABLE III
TECHNICS USED

Technic	No. Cases	Brachial Plexus Block		Complete Anesthesia		Partial Failure		Complete Failure	
		No.	Per Cent	No.	Per Cent	No.	Per Cent	No.	Per Cent
I. Supraclavicular									
(a) 1 needle with paresthesia									
1. one block	871	871	79.2	800	92.0	39	4.4	32	3.6
2. block repeated once	44	88	8.0	86	97.7	0	0.00	2	2.3
3. block repeated twice	3	9	0.81	8	89.0	1	11.0	1	0.00
(b) Patrick	39	39	3.54	38	97.5	1	2.5	0	0.00
(c) Three needles	12	12	1.09	9	75.0	2	16.7	1	8.3
(d) Continuous brachial plexus block	70	70	6.36	61	87.0	7	10.0	2	3.0
(e) Bilateral brachial plexus block	2	4	0.36	4	100.0	0	0.00	0	0.00
II. Infraclavicular	3	3	0.28	2	66.0	1	33.3	0	0.00
III. Axillary	2	2	0.18	1	50.0	0	0.00	1	50.0
IV. Paravertebral	2	2	0.18	2	100.0	0	0.00	0	0.00
Total	1048	1100	100.0	1011	91.81	51	4.64	38	3.45

TABLE IV
ADDITIONAL COMPLEMENTARY ANESTHESIA

Agent or Technic	No. Cases	Reason
1. Pentothal	14	Slow onset of brachial plexus block
2. Pentothal	38	For apprehension
3. Pentothal—N_2O	39	Block disappeared before end of operation
4. Pentothal	14	Procaine reactions
5. Morphine	48	For apprehension
6. 5% alcohol in glucose	28	For apprehension
7. Repeated injection	47	Block disappeared before end of operation
8. Spinal	43	When bone grafts were taken from lower extremity
9. Superficial cerv. plexus block	12	For surgery of upper arm involving deltoid area
10. Bracelet at upper arm	233	For surgery of upper one-third of the arm involving deltoid or medial aspect of arm or use of tourniquet
Total	516	

Whenever additional supplementary anesthesia was necessary because of total failure of the block, pentothal-nitrous oxide-oxygen or any other available general anesthesia was used. If only part of the plexus was anesthetized and time was available, the unanesthetized nerve was blocked at the elbow or wrist or infiltration anesthesia was used. If this was inconvenient, a general anesthetic was given. Regardless of the supplementary technic, it is very important to have the patient feel *no* pain. (Tables IV, V and VI.)

TABLE V
ADDITIONAL SUPPLEMENTARY ANESTHESIA

Agent or Technic	Partial Failures		Complete Failures	
	No. Cases	Per Cent	No. Cases	Per Cent
1. Pentothal-N2o-o2	38	74.0	28	73.7
2. N2o-o2-ether	0	0.0	5	13.2
3. Nerve blocks (ulna, median, radial, at elbow)	1	2.0	2	5.2
4. Wrist block	0	0.0	1	2.7
5. Infiltration	12	24.0	2	5.2
Total	51	100.0	38	100.0

In the earlier cases 2 per cent procaine was used exclusively, except in a few cases in which it was considered advantageous for the patient to retain some motor power in order to help the surgeon identify tendons. In these cases 1 per cent procaine was used. Later 1.5 per cent metycaine was used and it was found to be of longer duration. In July, 1946, an article by Brown et al.,[32] advocating the use of dilute pontocaine solution for continuous causal anesthesia, suggested its use in all forms of regional procedures including brachial blocks. They presented figures which were quoted by Saklad[34] from the work of Novak on the comparative potency and toxicity of procaine, metycaine, pontocaine and nupercaine which are reproduced in Table VII.

These figures were impressive because they corroborated our clinical experience obtained from the use of all these agents in spinal anesthesia. It is important to note that the ten-fold increase in the potency of pontocaine more than offsets the six-fold

TABLE VI
AGENTS USED

Agents Used	No. Cases	Dosage Used			Reactions	
		Maximum	Minimum	Average	Severe	Minimal
Procaine 1%	11	80 cc.	18 cc.	60 cc.	0	0
Procaine 2% (J.J.B.)	560	125	8	46.6	3	2
Procaine 2% (D.C.M.)	150	80	40	60.0	2	4
Pontocaine 0.15% (J.J.B.)	74	70	15	40.6	0	0
Pontocaine 0.15% (D.C.M.)	145	125	50	88.0	1	2
Pontocaine .10%	62	80	40	54.0	0	0
Pontocaine .075%	5	40	25	30.0	0	0
Metycaine 1.5%	27	40	25	39.0	0	0
Pontocaine .15% / Procaine 1%	10	100	40	65.0	0	0
Intracaine 1.5%	1	40	40	40.0	0	0
Intracaine 5% in oil	3	15	15	15.0	0	0

The cases done with 2 per cent procaine and 0.15 per cent pontocaine have been segregated to show that different amounts of the drugs have been used by two separate groups with the same end results. The maximum dose of 125 cc. of 2 per cent procaine was not used in a single injection but in three subsequent injections used by continuous technic.

increase in the absolute toxicity compared with procaine, giving pontocaine a corrected toxicity ratio of 0.58.

We started to use dilute pontocaine solutions for brachial blocks hoping to increase the duration of anesthesia. In the first few cases 50 cc. of 0.15 per cent (75 mg.) pontocaine with epinephrine 1:200,000 was used, which has a corrected toxicity ratio of 0.44 (if it is assumed that the equivalent dose of procaine is 50 cc. of 2 per cent). The results startled us for in the first three cases the average duration of anesthesia was six hours and forty-three minutes. It was decided to run a very carefully controlled series of cases in order to compare 2 per cent procaine, 1.5 per cent metycaine and 0.15 per cent pontocaine for brachial plexus block anesthesia. In order to make conditions as similar as possible, three experienced anesthesiologists performed all the blocks without selection of cases, using the one needle technic with paresthesia. The three drugs were used consecutively and the same amount of solution was used to eliminate the variation due to bulk and dosage. Exactly 40 cc. of 2 per cent procaine or 1.5 per cent metycaine or 0.15 per cent pontocaine was used with epinephrine 1:200,000. The time the block was completed was recorded as zero hour and then the attendant carefully observed the effects of the block, such as sympathetic block, loss of pain, proprioception and touch, loss of motor power and signs or symptoms of toxicity. Postoperatively the blocks were followed by the same attendant and charted. A summary of the results is presented in Tables VIII and IX. Table VIII shows the time necessary for the loss of pain and touch sensation and motor power. Table IX shows the time that analgesia was present. These figures clearly show that the duration of anesthesia due to pontocaine is several times that of the other drugs and without any apparent increase in toxicity. As a matter of fact, it is our conviction that dilute pontocaine solutions cause less toxic reactions even when given in large amounts. Moore[34] has used up to 125 mg. of pontocaine in a large number of cases requiring regional anesthetic procedures, without any evidence of toxicity. This corroborates the work of Brown et al.[32] and

TABLE VII
COMPARATIVE FATAL INTRAVENOUS DOSE OF LOCAL ANESTHETICS IN CATS (NOWAK)

Local Anesthetic	Av. Fatal Dose (mg./Kg.)	Ratio Compared with Procaine	Equivalent Dosage Ratio	Corrected Toxicity Ratio Compared with Procaine
Procaine	49.6	1.0	1.0	1.0
Metycaine	28.8	1.7	0.8	1.36
Pontocaine	8.6	5.8	0.1	0.58
Nupercaine	3.5	14.2	0.05	0.71

TABLE VIII
TIME FOR ONSET OF ANESTHESIA

Agent Used	No. Cases	Time for Onset of Anesthesia (in minutes)								
		Pain Loss			Touch Loss			Motor Loss		
		Max.	Min.	Av.	Max.	Min.	Av.	Max.	Min.	Av.
2% Procaine 40 cc	50	33	5	16.4	53	5	24.0	42	10	19.5
0.15% Pontocaine	50	35	5	23.3	45	5	34.3	50	5	26.6
1.5% Metycaine	25	32	3	12.0	52	12	19.0	35	8	16.0

James.[35] The latter administered as high as 2 mg. of pontocaine (amethocaine) per pound of body weight without observing any toxic effects. This prolonged action of pontocaine offers many advantages to the regional anesthetist. It obviates the need for additional anesthesia in long operations. It is a great comfort to the surgeon and anesthetist to know that the anesthesia will not disappear before the operation is finished. Our surgeons have shown their appreciation for this type of prolonged anesthesia by requesting it for all of the surgical operations of the upper extremity. It also allows the busy anesthesiologist to do regional anesthesia without undue waste of time. The following cases illustrate this well:

TABLE IX
DURATION OF ANALGESIA

Drugs	No. Cases	Dose, (cc.)	Duration of Analgesia		
			Minimum	Maximum	Average
0.15% Pontocaine	50	40	1 hr. 50 min.	12 hr. 50 min.	6 hr. 18 min.
2% Procaine	50	40	40 min.	4 hr. 5 min.	1 hr. 31 min.
1.5% Metycaine	25	40	60 min.	3 hr. 20 min.	1 hr. 56 min.

M. D. and J. B. were both scheduled for operations of the upper extremity with brachial block anesthesia for 10 A.M. The anesthetist had one case starting at 8 A.M. which would probably last until after 10 A.M. He therefore blocked M. D. at 7 A.M. and J. B. at 7:15 A.M., and observed them until 7:45 A.M. By this time perfect anesthesia without any signs of toxicity was evident in both cases and he was able to start his 8 A.M. case. Both patients were operated upon at 10 A.M. without any additional anesthesia. M. D. had anesthesia until 4:45 P.M. and J. B. was discharged at 3:30 P.M. without having had any postoperative sedation. At the time of discharge she still had complete anesthesia.

H. E. was scheduled for a 11 A.M. surgery. The same circumstances prevailed. He was blocked at 7 A.M., operated upon from 11:05 A.M. to 1 P.M. and had complete analgesia until 5:15 P.M. He required only one postoperative "hypo" for the entire evening and night.

It is important to emphasize at this point that by these illustrations we do not advocate administration of a block and then forgetting the patient. Whenever it is necessary to block these patients ahead of time, they should be under the observation of some one, preferably in the anesthesia room during the preoperative period. Of course, during the operation the anesthetist should always be in attendance in case a complementary or supplementary anesthesia is necessary.

The patients appreciate this postoperative analgesia without the drowsiness, hypnosis and sometimes nausea which accompanies the usual general anesthesia and the postoperative sedation. Many of the patients expressed gratitude to the surgeon for this postoperative painlessness and many of them requested brachial plexus block for subsequent operations. This is well illustrated by the following case:

J. R. was a six year old private patient who entered the hospital for the first time on August 18, 1947, with a complete transverse fracture of the radius and ulna. With brachial block anesthesia the fracture was manipulated several times in the fluoroscopy room, a cast was applied and the patient was sent home. He returned the following day with repeated displacements of the bone fragments. Manipulation was again done with vinethene-ether anesthesia administered by a technician. The cast was reapplied and the patient sent home as soon as he was able to walk. The fracture again became displaced and on August 25th an open reduction with plating was performed with brachial plexus anesthesia. Six months

later the patient entered the hospital for removal of the plate. He specifically requested of the surgeon that he wanted a block and did not want to go to sleep. The next morning the plate was removed with brachial block anesthesia.

Such prolonged anesthesia is also of value in patients who have circulatory disturbances in the extremity as they benefit from the sympathetic block which accompanies the anesthesia.

Since the completion of the control series we have used pontocaine in many more patients requiring brachial plexus block and have used not only 0.15 per cent but also 0.10 and 0.075 per cent solutions. The latter dilution has been used whenever it is necessary for the patient to retain some motor power and also in children. The blocks on J. R. were done with 30 cc. of 0.075 with epinephrine 1.400,000. These dilute solutions do not cause anesthesia of the same duration but it is long enough for any operation.

COMPLICATIONS

The complications which we have encountered in these cases are tabulated in Table x. Pneumothorax was the most important of these complications although none of the patients who had it became distressed. All cleared up in a few days without sequelae.

Six severe toxic reactions occurred which were treated with pentothal and oxygen without any sequelae. Five of these occurred with 50 cc. of 2 per cent procaine. The others were of minimal nature and were cleared up without treatment although in many cases 50 mg. of pentothal were given in order to counteract them.

Four of the patients in this series had a transient and minimal degree of paresis and analgesia in the area supplied by the ulnar nerve. These occurred in hand cases operated by the same surgeon. Upon investigation it was found that the surgeon placed the arm on the table in a way which caused pressure on the nerve in the elbow. Upon change of position of the patient's arm in subsequent blocks done for the same surgeon no further complications were noted.

Puncture of the subclavian artery has occurred in many of the cases without any apparent complications. Of course, the needle was always withdrawn from the artery before injecting. We have always tried to palpate for hematomas following the puncture, particularly in thin individuals, and have not been able to discern any tumefaction.

TABLE X
COMPLICATIONS

Complications	No. Cases	Per Cent of Total
Pneumothorax	9	0.82
Drug reactions		
(a) severe	6	0.55
(b) minimal	8	0.73
Transient ulnar nerve paresis	4	0.36
Miscellaneous	7	0.64
Total	34	3.1

Phrenic nerve block with consequent diaphragmatic paralysis of that side may occur, particularly if a large amount of solution is used, but we have not observed any signs or symptoms which would be related to its presence. In a small group of patients roentgenograms were taken which failed to show any paralysis of the diaphragm. Bilateral brachial plexus block was used in two patients without any subjective or objective disturbances of respiration or circulation.

Cervicothoracic (stellate ganglion) sympathetic block has been observed in some of the cases.

SUMMARY AND CONCLUSIONS

1. The many advantages of brachial plexus block anesthesia have been reemphasized.

2. All American literature on the subject has been reviewed.

3. Several points in the "anesthetic" anatomy of the plexus have been stressed.

4. Eleven hundred brachial plexus blocks performed by thirty-four anesthesiologists for 1,048 operations are reported with a brief description of the technics used.

5. Perfect anesthesia was obtained in 91.9 per cent of the cases. Of the rest, 4.6 per cent had partial anesthesia and 3.5 per cent had no anesthesia.

6. Procaine, metycaine and pontocaine in different concentrations were used.

7. A vasoconstrictor was added to all solutions. Epinephrine in concentration of 1:200,000 was used in adult patients, while in children the concentration was 1:300,000 or 1:400,000.

8. The use of 2 per cent procaine, 1.5 per cent metycaine and 0.15 per cent pontocaine in a controlled series of cases are reported and analyzed. Pontocaine caused the longest anesthesia with an average duration of over six hours without any increase in toxicity.

9. The complications and difficulties encountered are reported.

10. From the results obtained in this series of cases, it is evident that brachial plexus block is an adequate form of anesthesia for any operation of the upper extremity and that with proper instructions, a thorough knowledge of anatomy and observation of certain principles any operator is able to obtain good results. It is hoped that more doctors take advantage of this adequate form of anesthesia in the future.*

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*Since this article was first written, 412 additional brachial plexus blocks have been done by the authors and their associates. The supraclavicular one-needle technic as herein described has been used. Pontocaine has been used in all of the cases although 2 per cent procaine has been added in a few instances whenever a faster induction of anesthesia was desired. In this group perfect anesthesia was obtained in 96.5 per cent of all the cases. All of these blocks have been carefully checked for duration of anesthesia which has been found to average over six hours. The complications of this added group have consisted of one pneumothorax. No drug reactions or neurologic sequelae have been observed.

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To find the effect of anesthesia and surgery on tuberculosis Parke et al. studied almost 300 patients in none of whom was major chest surgery done but in all of whom other operations were indicated and performed. When the tubercular patient was in an arrested state, as was true in over 10 per cent of these cases, anesthesia (of any type) and surgery did not produce an extension of the patient's pulmonary tuberculosis. However, especially when the patient had extensive pulmonary tuberculosis and positive sputa tests, Parke et al. found that postoperative extension of the patient's present pulmonary status is to be expected. Although the series is short (actually only 282 cases), the evidence points to the aforementioned conclusions and the authors are well justified in warning surgeons of possible hazards and complications in operating on such patients. Thus if a patient with active tuberculosis has chronic appendicitis or chronic cholecystitis, a hernia or any other surgical condition which does not require immediate surgery, the surgeon will be wiser to delay operation until the patient's pulmonary condition becomes arrested. (*Richard A. Leonardo, M.D.*)

INJECTION OF MANDIBULAR NERVE AND GASSERIAN GANGLION

AN ANATOMIC STUDY

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ALCOHOL injection of the gasserian ganglion has been used for the relief of trigeminal neuralgia since the beginning of this century. There are two principal methods: One is the ascending route first used by Schlösser.[1] His method was followed and modified by others.[2–14] All these authors have used the extrabuccal ascending route except Ostwalt who started his injection through the mucous membrane of the mouth (intrabuccal ascending route).

The other method is the horizontal or transzygomatic route. This was first used by Lévy and Baudouin.[15] It was repeated with slight variations by other operators.[16–26]

TECHNIC OF HORIZONTAL TRANS- OR SUBZYGOMATIC METHOD OF INJECTION

The aim is to inject the mandibular division of the trigeminal nerve at the point of its exit from the foramen ovale. A straight needle 10 cm. long and 1.0 to 1.5 mm. in diameter is used. Some operators use it fitted with a blunt stylet, others without a stylet. The needle is marked in centimeters from the point up to five so that the operator may know what depth he has reached.

The skin is prepared and anesthetized in the usual manner. The needle is inserted through the cheek behind the last upper molar at the lower border of the zygoma 2 to 2.5 cm. in front of the descending root of the zygoma, which can always be felt as a ridge close to the anterior bony border of the external auditory meatus. After the needle has pierced the skin the blunt stylet, when used, is pushed home and the deep tissues are penetrated with a blunt-ended instrument without injuring the deep vessels. The needle is directed slightly upward and a little backward hugging the base of the skull until it reaches the mandibular nerve at its exit from the foramen ovale at a depth of about 4 cm. from the zygoma. This depth varies slightly, depending upon the shape of the head and the thickness of soft parts, but it is never greater than 5.5 cm. from the surface. If difficulty is encountered in passing through the sigmoid notch of the mandible, it may be overcome either by having the patient's mouth wide open or by depressing the handle of the needle slightly. The needle passes through skin, subcutaneous tissue, masseter muscle, posterior portion of the temporal tendon, superior border of the external pterygoid muscle and anterior to the temporomandibular joint.

Frazier[23] and Grant[24] used an instrument called a zygometer. The use of this instrument, they thought, eliminated the uncertainty of being able to feel the descending root of the zygoma, thus making the point of needle puncture more accurate. Grant[24a] selected the 2 cm. mark in the lower bar of the zygometer in the standard position for the injection of the mandibular nerve. This corresponds approximately to the point of election described by Lévy and Baudouin.[15] In Grant's 162 injections on eighty-one cadavers the horizontal angle averaged 91 degrees and

the vertical angle 108 degrees. The nerve was reached at a depth of 4.5 cm.

De Froe and Wagenaar[25] found the pterygospinous foramen of Civinini in 5 per cent of European skulls. They mention that Haertel erroneously thought that the presence of such a foramen could prevent the injection of the semilunar (gasserian) ganglion of the trigeminal nerve through the foramen ovale. They point out that the presence of the partially or completely ossified pterygoalar ligament (ligamentum crotaphitico-buccinatorium of Hyrtl) can really make the injection of the semilunar ganglion impossible. My examination of 6,000 skulls[27, 27a] confirms their observation.

The roentgenologic technic of De Froe and Wagenaar[25] has made it possible to exclude poor results with certainty. They give credit to Haertel for the first successful visualization of the foramen ovale in the skiagraph of the base of the skull. According to them Götze also used the roentgenologic examination of the foramen ovale successfully.

They describe Haertel's technic and an improvement of it by Brücke for the x-ray examination of the foramen ovale. deFroe and Wagenaar[25] show roentgenograms of the foramen ovale with and without the presence of the ossified pterygospinous and pterygoalar ligaments.

Sunderland[26] describes a "pterygospinous bar," but apparently he does not distinguish between the pterygospinous bar and the pterygoalar bar which are two definitely separate and different entities. The former completes the pterygospinous foramen of Civinini while the latter completes the pterygoalar foramen (porus crotaphitico-buccinatorius of Hyrtl). His figures v and ix illustrate the last mentioned bar which makes the introduction of the injection needle into the foramen ovale by the horizontal transzygomatic route impossible. His figure iv represents the pterygospinous bar which, as he states, offers no obstacle for the passage of the needle into the foramen ovale.

TECHNIC OF ASCENDING INTRA- OR EXTRABUCCAL METHOD OF INJECTION

Apparently Schlösser[1] was the first to use this method. He did not describe his technic in detail. Hecht[4] learned this method from Kiliani[3] who in turn was personally instructed by Schlösser. Hecht[4] described deep injection of the mandibular nerve at the foramen ovale by Schlösser's method as follows: "Having first introduced his fingers into the mouth back of the last molar as a guide, he forces the longest one of his three especially devised needles through the cheek, (extrabuccal) under the periosteum to the pterygoid plate and upward on it until about 2½ inches of the needle are buried; lowering the handle of the needle admits of advancing the point about another one-fourth inch toward the base, where it is held in place. Then deftly feeling the way backward, and keeping closely to the bone for about half an inch, one feels the needle enter the foramen ovale and the injection is begun. Narcosis is hardly ever necessary, and should be omitted in order to get the benefit of the patient's appreciation as to any sensory change following the injection."

Ostwalt[2] claims to have improved upon this method in some essential points. He uses a bayonet-shaped needle and introduces it directly behind the upper third molar (intrabuccal). He pushes it through a rather thick submucous tissue and the external pterygoid muscle, or around its lower border to the external pterygoid plate. Then he moves the needle slowly and carefully upward until it reaches the infratemporal surface of the great wing of the sphenoid bone. He then slides the point of the needle backward between the infratemporal surface and the external pterygoid plate as long as bony resistance is felt. As soon as this resistance ceases the needle has entered the foramen ovale.

Haertel's approach[5] to the gasserian ganglion through the foramen ovale is practical and useful. His method is an improvement over the method of Schlösser.

Haertel points the needle to the pupil of the eye on the same side. The location of the foramen ovale is at a point on the base of the skull where a perpendicular plane through the center of the pupil and a horizontal plane through the articular eminence bisect. He takes roentgenograms of the patient's skull in a certain position to see the location and shape of the foramen ovale and to find out if there are any bony anomalies which might obstruct the passage of the needle into the foramen ovale.

Grinker[6] uses Haertel's method. He describes his own technic but his description is not very clear.

Under the fluoroscope Pollock and Potter[7] introduce a catheter into the eustachian tube as a guide for the location of the foramen ovale. They conclude that "employing the shadow cast by the anterior border of the petrous portion of the temporal bone, on a fluoroscope, as a line of orientation injection of the gasserian ganglion by Haertel's method is made more certain."

In Braun's book, translated by M. L. Harris,[8] the technic of injection of the gasserian ganglion is essentially the same as that used by Haertel.

Irger[9,29] uses a needle 10 to 15 cm. long and 0.8 mm. thick. The needle is furnished with a bar which could be replaced by a cork. He measures from the point of the needle to the bar a distance equal to that from the angle of the mandible (the mouth of the patient being closed) to the upper margin of the articular tubercle. He introduces the needle into the skin touching the medial side of the angle of the mandible. It is then slowly advanced to the bar following the direction of the skull base. It is to be noted that the articular tubercles and the oval foramina are upon one line. The longitudinal direction of the needle must coincide with the line uniting the puncture point with the upper margin of the articular tubercle.

According to Morris,[10] Haertel inserted the needle at about the level of the second upper molar, guiding it with a finger in the mouth until the point of the needle reached the area of bone in front and lateral to the foramen ovale. He considered this surface of the bone "so characteristically hard and smooth that it could be used as a landmark to the foramen, which was the first depression or irregularity met with on it in working the point of the needle backwards." In this way he was able to locate the foramen ovale with accuracy.

Morris[10] states that, "the (mandibular) nerve may run deep to the accessory ossifications in this region, and at a depth which makes its safe infiltration with alcohol impossible."

Morris[10] makes the skin puncture 1 to 2 cm. lateral to the angle of the mouth or 2 to 3 cm. above this point, the former being referred to as the "vertical" type, the latter as the "horizontal" type. He guides the point of the needle between the buccinator muscle and the mandible on the infratemporal surface of the sphenoid bone, and with the aid of this surface and of the adjacent external pterygoid plate localizes the foramen ovale.

Souttar[11] inserts the needle into the cheek 1 inch external to the angle of the mouth, directing it upward and inward toward the lambda, the point on the skull where the lambdoid and sagittal sutures meet. After passing through the cheek, the needle enters the internal pterygoid muscle on the inner side of the coronoid process. Leaving this, it enters the external pterygoid and comes to rest at the root of the external pterygoid plate just in front of the foramen ovale and on the base of the skull. The needle is now partly withdrawn and directed slightly posteriorly to its former line, when the point should pass through the foramen ovale into the ganglion. The lambda, he claims, is his own landmark. It is easily felt as a depression on practically every skull; and if the index-finger of the left hand is placed on this point, it will be found a very easy matter to direct the needle toward it.

Horrax and Poppen[12] use essentially the approaches to the foramen ovale described

by Haertel and by Harris. Their statement that "the foramen ovale lies just posterior and slightly medial to it (external pterygoid plate) (Fig. 3)" is obviously in error, for a careful study of this figure in their article, as well as my examination of skulls, shows that the foramen ovale lies just posterior and slightly *lateral* not medial to the external pterygoid plate.

Putnam and Hampton[13] apply practically the same technic employed by Haertel.

W. Harris[14] states, " . . . the lateral route through the sigmoid notch is often less satisfactory for injecting the ganglion than it is for the third division alone, owing to the difficulty in many cases of getting the needle to pass through the lips of the foramen." He states further: "Although I used this route for a number of years, for the last three or four years I have adopted for preference the anterior route that was described many years ago by Haertel, which, although it is longer, has the advantage of being a much steeper approach, so that there is no difficulty in passing the needle through the foramen. It is, however, in my opinion a route that required much more experience than the lateral route." In general the method is similar to the extrabuccal route of Haertel.

W. Harris[30] in the last thirty years has treated over 2,500 cases of trigeminal neuralgias mostly by alcohol injections. Therefore, he believes and justly so, that an analysis of his results "may be useful in establishing the value and limitations of this method."

COMMENT

From the foregoing description it is obvious that there are two principal methods of injection used in the treatment of mandibular neuralgia. One is the horizontal or transzygomatic route, the other is the ascending method. The former method is comparatively easy to master, but the latter needs more experience and skill. It is, however, anatomically impossible to use the horizontal method in a certain per-

FIG. 1. Base of skull. 1, pterygo-alar bar; 2, one end of white paper is inserted into the petrygo-alar foramen (porus crotaphitico-buccinatorius of Hyrtl) under 1; 3, foramen ovale; 4, foramen lacerum.

centage of cases due to the presence of a bony bar which completes the pterygo-alar foramen (porus crotaphitico-buccinatorius of Hyrtl), Chouké.[27, 27a]

Both these methods were tried on 100 embalmed cadavers. It was very easy to reach the foramen ovale by the horizontal transzygomatic route, except when the pterygo-alar foramen was present.

The foramen ovale was entered by the ascending method of Haertel only after many trials, but in no case was the presence of the pterygo-alar foramen responsible for failure of this method.

Since the publication of my two papers on the subject, I have examined 1,711 additional skulls bringing the total number of skulls observed to 6,000. In these 6,000 skulls the pterygo-alar foramen was complete 463 times (7.72 per cent). It was incomplete in 659 (14.79 per cent) of 4,456 skulls.

The pterygo-alar foramen, when present, is formed by a bar of bone running from the root of the lateral lamina of the pterygoid process of the sphenoid to the undersurface of the greater wing of the same bone. (Fig. 1.) Its presence forms an obstruction in the path of the needle inserted by the horizontal transzygomatic route and intended to reach the foramen ovale for injecting the mandibular division of the

trigeminal nerve or the gasserian (semilunar) ganglion. Quite often this bony bar is very strong and heavy. In dry skulls having the bar one cannot even see the foramen ovale from the lateral side much less pass a needle into it. In a living person presence of the bar would preclude using the horizontal approach. In cases in which the aforementioned bony bar is thin, one can see the foramen ovale in a dry skull but the passage of the needle is still impossible.

In the presence of such a bony bar the ascending route, originated by Schlösser and improved upon by Haertel and others, affords a means for entering the foramen ovale without obstacle. However, this method requires more experience and skill. It is apparently for this reason, although he did not say so, that W. Harris[30] after making injections into the foramen ovale in over 1,400 patients has now adopted the modified Schlösser's ascending technic of injection in preference to his own horizontal transzygomatic method.

Recently De Froe and Wagenaar[25] perfected a roentgenologic technic whereby they can visualize the foramen ovale and the presence or absence of the pterygo-alar foramen. In this way they can reach the foramen ovale with certainty. It would seem possible that one could inject the mandibular nerve or the gasserian ganglion under the fluoroscope, thus avoiding all uncertainties about endangering other structures.

SUMMARY

Two principal methods have been described for injecting the mandibular division of the trigeminal nerve or the gasserian (semilunar) ganglion; one is the horizontal transzygomatic route and the other is the ascending route started in the skin near the angle of the mouth. In about 8 to 10 per cent of individuals an anatomic anomaly, pterygo-alar foramen (porus crotaphitico-buccinatorius of Hyrtl) is present. The presence of such an anomaly makes the horizontal transzygomatic method of injection physically impossible.

The presence or absence of another anomaly in the same region, namely, the foramen pterygospinosum of Civinini offers no barrier by either route to a needle directed toward the foramen ovale, for the axis of the foramen of Civinini is vertical and at about right angles to the horizontal axis of the pterygo-alar foramen.

The pterygo-alar foramen is found in a higher percentage of negroes than in whites.

For best clinical results in the treatment of trigeminal neuralgia by injection through the foramen ovale, it is suggested that the ascending approach be used, preferably under the fluoroscope when practicable.

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CLINICAL MANIFESTATIONS OF THE SYMPATHETIC REFLEX ARC

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IN a paper read in June, 1947, before the American Association for the Surgery of Trauma I presented neurophysiologic evidence of the presence of a sympathetic reflex arc[1] and I then touched briefly upon its clinical significance. During the past several years we have read of individual suggestions by clinicians recommending sympathetic block for the relief of one or another obscure clinical condition. These suggestions, appearing isolated and totally unconnected, are further demonstrations of the clinical significance of the sympathetic reflex arc. This entire problem awaits an analytic and systematic interpretation in which all the little understood conditions would be presented as having a common etiology and, therefore, a common therapy.

To stimulate study and thought by the clinician who, in contrast to the laboratory investigator, observes at firsthand numerous manifestations of the reflex, I shall discuss briefly several clinical conditions in which the sympathetic reflex arc is of supreme etiologic importance.

Crush Syndrome. During London's 1941 air raids physicians found that victims whose legs had been pinned under timbers and masonry for several hours died mysteriously of kidney failure. This strange condition was called "crush syndrome." Injuries to the vessels of the crushed extremity reflected the blood vessels of the kidneys into spasm and thus caused anuria. A gradual increase in the blood pressure followed. This clinical syndrome has been studied intensively during the past few years by pathologists. While pathologists still talk about the release of toxic substances by crushing injuries to the muscles of the limb and about some unknown muscle-endocrine mechanism responsible for the observed intense vasoconstriction and ischemia of the glomerular tuft, they agree that vasoconstriction of the kidneys is always present in the postglomerular arterioles. The steady rise of the blood pressure is a result of this vasoconstriction. Experimental data are now available which confirm the early appearance of vasoconstriction in crush wounds as seen by Keele and Slome following release of complete ischemia maintained for four hours in an extremity of a cat.[2] Of course, one must admit that the vasoconstriction initiated and caused by a crushed or ischemic limb is limited not only to the kidneys but it is in the kidneys that this vasoconstriction manifests itself most alarmingly. Considering all these proven facts it is logical and scientifically sound that repeated sympathetic blocking should take preference over all other measures in the treatment of a patient with a crush syndrome. Vasodilatation of the kidney arterioles and glomerular tufts is the first clear-cut aim of the clinician. Not all of us handling traumatic surgical material will see many cases of a well expressed crush syndrome but all of us have seen many border line cases in which in more or less extensive injuries to an extremity the patient shows numerous unexplained complications of a systemic nature despite good, conventional care. It should be an established rule that along with the management of the injured limb, a prompt and repeated blocking of the sympathetic is a condition without which the management is deficient. This is especially true in patients with a labile sympathetic system,

the one with cyanotic, clammy hands who is subject to instantaneous vasospastic reactions.

Cardiac Trauma. Another field in which many individual observations have not been fully understood is the field of vasospastic heart disease. It is only through observations by the surgeon interested in trauma of the heart that we are learning how to analyze and systematize our clinical observations. When a traumatised heart is exposed for repair, the most difficult task is to control the irritability of the heart muscle. It was found that spraying the exposed heart with a solution of novocain relieves this irritability. The novocain, by blocking the sympathetics, abolishes the spasm of the numerous small blood vessels of the exposed myocardium.

Maguire and Friswold[3] noticed that a seemingly trivial wound piercing the right ventricle near the atrioventricular groove without damage to the left coronary artery will cause electrocardiographic tracings consistent with a diagnosis of anterior infraction in 100 per cent of the cases. These typical tracings disappeared in from seven to ten days. This is an observation which gives credit to the investigative minds of these surgeons in contrast to the average surgeon who usually is so preoccupied with the mechanical details of his job that important observations escape him. This observation, which is baffling to the cardiologist, to my mind is explained by the distribution of the sympathetic system in the heart. For a study of this subject I refer you to an excellent monograph by Mueller.[4] The heart muscle shows an abundant supply of nerve fibers in the pectinate muscles, the trabecula carneae and in the papillar muscles. Incomparably more abundantly supplied is the region of the heart along the coronary sulci and the atrioventricular groove. There the heart is thickly covered with widely ramified bundles of the sympathetic nerves for at least 1 inch to each side of the groove or sulcus. Therefore, even a seemingly trivial wound in the neighborhood of the atrioventricular groove divides numerous sympathetic bundles causing an immediate and widespread spasm of the coronary ramifications with the typical electrocardiographic tracings. To some degree an analogous observation is seen in coronary disease when even a small ischemic area in the myocardium initiates a further spread through the sympathetic of a reflex spasm and leads to an aggravation of the disease. It is only logical, therefore, to suggest that measures aiming at vasodilatation through blocking of the sympathetic arc in the myocardium should follow immediately after the conventional administration of analgesics and oxygen in the treatment of coronary disease. Such a sympathetic block is not to be viewed as a pain-relieving measure only as it is at present. It also follows that whenever time permits, a sympathetic block should precede any surgery on the myocardium.

Postvagotomy Complications. We now come to a field in which the role of the sympathetic reflex arc may be studied as a scientifically conducted laboratory experiment. With the enthusiastic support of Gragstedt, section of the vagus nerves for the cure of peptic ulcer recently acquired great publicity. This same operation was tried in Germany a quarter of a century ago and was discarded after several trials. As usual the enthusiasm of the proponents of this operation blinded them to the complications which follow this most drastic of surgical operations. Gradually reports appeared mentioning some quite unpleasant complications of the section of these most important vegetative nerves. But even in Chicago, the headquarters of vagotomy, no complications are known to the surgeons. In adjoining Minnesota and even among the stoic New England patients many and varied complications were noticed by the surgeons.

The gastrointestinal tract is innervated by both the sympathetic and parasympathetic systems. The parasympathetic system consists of the vagus nerves and of the splenic nerve which is the sacral divi-

sion of the parasympathetic system. The vagi supply the gastrointestinal tract down to the splenic flexure of the colon while the pelvic nerve supplies the descending colon. When the vagus nerves are cut in the chest or about their exit from the thorax, the sympathetic system is left without an antagonist from the stomach down to the splenic flexure of the colon. The postvagotomy complications naturally are the result of sympathetic irritability. In other words we are dealing with a sympathetic reflex arc which is as unimpeded as the knee jerk in an upper neuron lesion. Irritations, which under normal conditions would become neutralized by the antagonistic action of the vagus, lead to serious complications in the absence of this antagonist.

I had almost no experience with postvagotomy complications until May, 1947, when a vagotomy was done upon myself in the course of an esophagectomy, playing havoc with my digestion. Of course, I have studied my postvagotomy complications with greater care and interest than is usually the case in a follow-up clinic or in cases in which the busy surgeon leaves this study to one of his junior assistants.

Immediately following the vagotomy a number of complications appear which confuse the patient. After a few weeks the complications assert themselves and crystallize. In my own case they have continued with some brief intermissions for the past twelve months. These complications appear in episodes or bouts and are more frequent in cold or damp weather. Exposure or chilling of the long thoracotomy scar immediately reflects in a new bout of eructations, regurgitations, nausea, occasional vomiting of white, foamy, gastric secretion, abdominal distention and pain in the right lower quadrant and throughout the lower abdomen. The eructation and regurgitation result from a dilation of the stomach through contraction of the pylorus by the inhibiting action of the sympathetic system. Inhibition of the movements of the small gut and the proximal two-thirds of the colon by the sympathetic leads to stasis. The overfilled, small gut causes pain typical of an intestinal obstruction with loud borborygmus. This may persist for days until a whistling sound of escape of intestinal gas through the splenic flexure of the colon gives full relief. This terminates the episode but not for long. An exposure to cold of my frostbitten finger or even an arduous argument or outburst of temper again reflects in a new bout of sympathetic crises. During the bout, turning from my back to my side and the consequent falling of the intestines to the dependent side, immediately exacerbates the pain. This is then accompanied by profuse perspiration (a sympathetic reaction), chill and tingling of the skin. Even loud talk and noises of various kinds increase the colicky abdominal pain.

From studying my own case I wish to state most emphatically that vagotomy is a highly expensive surgical procedure. The price the patients pay is entirely out of all proportion to the disability caused by the peptic ulcer. I believe that even in esophagectomy the surgeon should make a real effort to save the vagus nerves.

SUMMARY AND CONCLUSIONS

I have spoken here about the role of the sympathetic reflex arc in a number of important little understood conditions. As we have seen, the underlying disturbance of the crush syndrome is renal vasospasm and subsequent anuria. Recently clinicians have reported rapid control of eclampsia by means of sympathetic block achieved by spinal or high caudal anesthesia. This observation supports the suggestion that the pathologic physiology of eclampsia is mainly sympathetic vasospasm of the kidneys. Another recent observation is that paravertebral sympathetic block relieves the swollen hands and feet, muscle spasm and tenderness of polio victims. While we know that spasm is not the most damaging effect of the disease, it is logical to believe that a sympathetic block will accomplish more

with less in relieving this spasm than the time and effort-consuming Kenny method.

In my paper before the American Association for the Surgery of Trauma last year I expressed the view that the presupposed decussation in the pons cerebri of *all* post-ganglionic sympathetic fibers destined for the blood vessels is not borne out clinically. Recently Gilbert and de Takats, in treating cerebral vascular insult (another manifestation of vasopasm) with blocking of the sympathetic in the Stellate ganglion, insist upon blocking the ipsolateral ganglion.[5] This observation is in direct support of my view on decussation of the sympathetic fibers. Thus clinical observations are again at variance with the views expressed by neuro-anatomists and physiologists.

I have tried to give a few high spots of the field of pathologic physiology centering about the sympathetic reflex arc. It is an enormous field which requires intensive study, analysis, correlation and systematization.

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Streamlined Articles

FACTORS WHICH INFLUENCE MORTALITY IN DUODENAL AND GASTRIC SURGERY*

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DRAGSTEDT'S work has focused attention again on the subject of duodenal and gastric ulcer.[18] His work is epochal and brilliant. We had hopes that out of his observations would arise a new and more hopeful period. Proper evaluation, however, will not be possible for several years.

In the meantime, partial gastrectomy is the most satisfactory operation at our disposal. The specter of high mortality, however, is still present in any but the most expert hands. The writer has had an experience of over 500 partial gastrectomies and has reduced mortality to less than 5 per cent. Indeed, the last sixty operations were performed without a death. In order to assist others also to lower mortality, it is believed that a statement of the factors influencing mortality should be worth while.

It must be remembered that these patients suffer chronically from dehydration, malnutrition, deficiency states, poorly functioning liver, kidneys and bowels in varying degrees; and often the heart itself may be deficient in reserve. The habit of admitting a patient one day and operating the next must be deplored. He must be kept long enough to allow a careful laboratory study, and sufficient time must be taken to treat the above conditions and to insure good renal and hepatic function. This will take a minimum of a week and preferably longer.

PREOPERATIVE CONSIDERATION

Routine blood count, hemoglobin, hematocrit, urinalysis and Wassermann tests are ordered. Also ordered are serum protein, albumin-globulin ratio, nitrogen, chlorides and carbon dioxide combining power. Electrocardiograms are requested.

Dehydration may be quite marked in this type of patient. This subject is adequately covered by many others.[1,2,3]

Serum Proteins. Hypoproteinemia must simultaneously be corrected. It is also frequently present in this type of case. Its effect is widespread on the general economy and welfare of the patient. It has been pointed out that the viscosity of serum proteins is essential to hold fluid in the blood stream. Adequate proteins, therefore, prevent edema in the gastric wall. If this is present at the time of surgery, the tissues are friable, hold stitches poorly and may be the cause of leakage. In fact, surgery in the presence of edema is definitely hazardous. Edema may cause swelling and obstruction of the outlet of the stomach following surgery. Wound healing is also hindered by hypoproteinemia.[9,10] In addition, proteins are essential to the proper metabolism of the liver and act as a buffer there. It is well known that the liver stands the toxic effect of anesthesia better if well supplied with proteins.[11] Proteins are also essential for their nutritive value. While carbohydrates and fats are also necessary, proteins are of the utmost value to build up tissues.

The most rapid method of building up serum proteins is by the administration of blood plasma and whole blood. Amino acids given intravenously will build up the pro-

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teins more slowly. Many surgeons have used amino acids intravenously and have been disturbed by severe reactions in their patients. If the solution is run in slowly, taking from two to three hours' time, very few reactions will be encountered.

Sodium chloride is often depleted by excessive loss as in vomiting or in gastric suction. This loss must be compensated if we expect the normal urinary output.

Glucose solutions should be given[12,13] since these patients need calories and the liver needs an adequate supply to build up reserve of glycogen. If a sufficient amount is not administered, the proteins and fats will be used up. The latter will not be properly oxidized and results in acidosis.

Vitamin Deficiency. Vitamin deficiency must be treated as it is present in practically all cases. Its effect on the general well being and on wound healing has been emphasized by G. H. Bourne[14] and by Bartlett, Jones and Ryan.[15]

Preoperative Care of Obstruction of the Duodenum. Where there is obstruction to the pylorus, there usually is considerable edema in the stomach wall. If operation is attempted, this edema materially adds to the danger of leakage. Continuous drainage of the stomach for at least four days reduces this edema and is absolutely essential. One can add that the electrolyte balance must be watched and the amount of chloride loss replaced.

OPERATIVE CONSIDERATIONS

Choice of Operation. Operations have run the gamut from simple excision of the ulcer, pyloroplasties, gastroenterostomy, pylorectomies, followed by gastroduodenostomy and, finally, partial gastric resection. We use a simplified Polya resection by the anterior route, described and published in 1940.[19] The method is an "open" technic using neither clamps nor cautery, believing that these cause damage to the tissues and delay surgery.

It is important to remove the duodenal ulcer when possible. It is our belief that more satisfactory results are obtained when this is done. This is not easy in a high percentage of cases as the ulcer may be low and there may be considerable induration around it. We dissect as low as possible. Often identification of the common duct will assist in estimating how low we can proceed. Mobilization of the duodenum often is of value, then remove the mucous membrane with a scissors or even a knife, coring it out as is done with the cervix. By this procedure, we often can reach a much lower point in the duodenum than would be possible by external dissection and have been able to remove the ulcer or sew the lumen across below the ulcer area. Only by an open method could this be done.

The duodenum is closed with No. 000 chromic catgut and reinforced with interrupted silk. Usually this takes in the capsule of the pancreas and turns in the suture line effectively. Omentum is then sutured over this area. We cannot emphasize too much the safety of the open method of suture without the use of clamps or cautery. No peritonitis has ever been seen. Furthermore, we have had no case of leakage in the last ten years. (Figs. 1 to 5.)

We perform an anterior Polya operation routinely. When we find the omentum heavy and thick, we remove a section and then the jejunal loop may be brought up adequately without tension. We believe that the anterior method is the one choice as it can be accomplished with much more speed, is less likely to have mechanical complications and permits adequate resection. We remove at least two-thirds of the stomach. It is important to attach the jejunum so that the efferent loop leaves the greater curvature. We have found that the left lobe of the liver presses on the jejunal loop tending to kink it somewhat. This seems to be unimportant if the efferent loop comes off the greater curvature. No difficulties in emptying have been experienced since we began anastomosing in this manner.

Anastomosis to the full width of the stomach is performed. No clamps are used

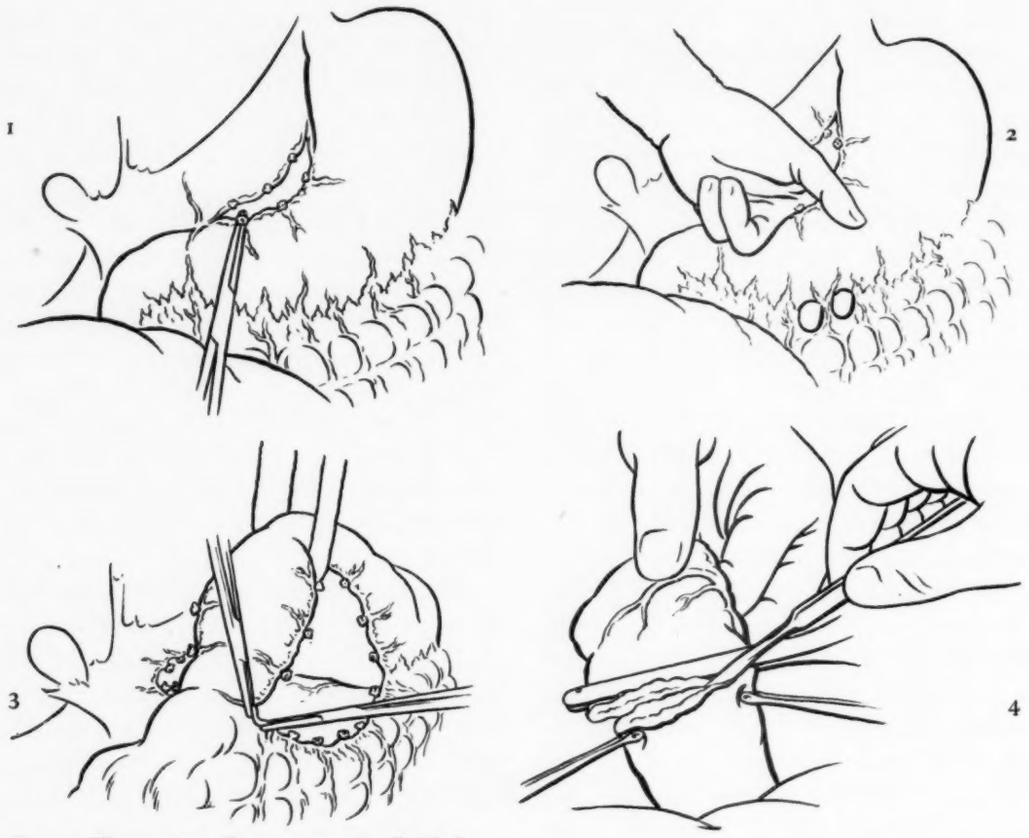

FIG. 1. The gastrocolic omentum is divided.
FIG. 2. The fingers are brought through the gastrohepatic omentum and out through the gastrocolic omentum.
FIG. 3. The gastrocolic omentum is divided and ligated.
FIG. 4. The duodenum is clamped with a Peyer clamp and divided openly below this point.

as these serve no useful purpose and, on the contrary, crush the tissue which has to be removed later. This is time-consuming and unnecessary. With no clamps applied the muscles of the stomach contract and reduce the size of the transverse diameter so that the anastomosis is not unduly large.

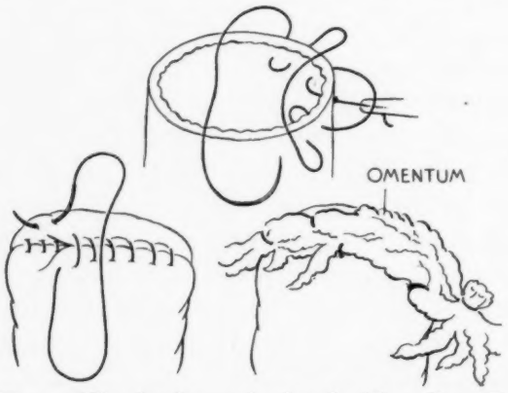

FIG. 5. The duodenum is closed with a Connell inversion stitch followed by a serous layer of catgut. A third layer of interrupted silk sutures is used and the area covered with omentum.

We have little or no spillage as the stomach is sucked dry by a suction tip. No matter what method is used, the stomach has to be opened. No peritonitis has ever been experienced as a result of our open method.

The opening in the jejunum is curved down the two limbs toward the ends. When suturing is completed, this enlarges the openings somewhat. This we believe important.

Bleeding points are carefully caught up and tied separately with No. ooo chromic catgut. This makes a cleaner operation and insures against postoperative hemorrhage.

Anastomosis is accomplished by a running suture of No. ooo chromic catgut; then the stomach and jejunum are opened.

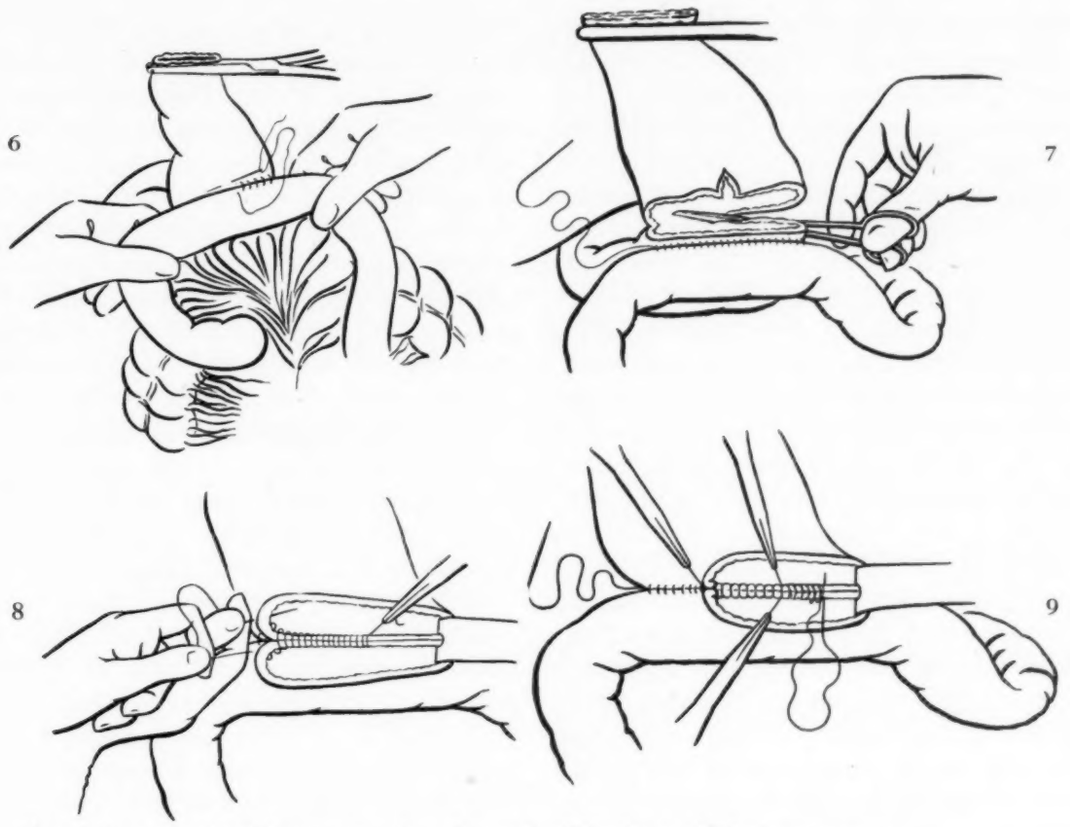

FIG. 6. A serous stitch is run; note that the proximal loop is at the lesser curvature.
FIG. 7. The stomach may now be resected; a corresponding opening is made in the jejunum.
FIG. 8. Suture is started in the center at the back and continued around the end so that no critical point exists.
FIG. 9. A second suture starts at the middle and is continued around the other end; these two sutures close the anterior edges, using a Connell inversion stitch.

The posterior line of sutures is begun in the center. This allows the suturing around the ends to be continued without interruption onto the anterior and does away with the critical points. The second suture is started at the same point on the posterior and is continued in the opposite direction and around the anterior edges to meet the termination of the first line of sutures. The serous suture is then continued around the anterior surface to complete the anastomosis. Only two layers of suture are used. These are continuous. No reinforcing with silk is used. No leakage has ever been experienced, and there is no necessity to use interrupted sutures as these are so time-consuming. (Figs. 6 to 10.)

FIG. 10. The original serous stitch is now continued around the anterior to complete the operation.

This paper would not be complete without a word on the choice of incision. We use a transverse incision, curving with the

configuration of the ribs. The rectus and the external oblique muscles are divided and retracted down and the deeper layers are divided at a somewhat lower level. Thus when they are sutured, the lines of stitching are at different levels or "staggered." This gives a strong wound which after use for several years has never disrupted. The eighth nerve is not divided but is retracted down and outward. This incision gives excellent exposure and little, if any, use of retraction is necessary during the operation. This also adds to the ease of working, allows more rapidity and is less shocking to the patient.

POSTOPERATIVE COMPLICATIONS

Shock. The best treatment of shock is its prevention. A well prepared patient will rarely exhibit severe shock. Whole blood is considered the best prophylactic. A blood transfusion the evening before is routine and 1,000 cc. of blood are given during surgery. Usually too little blood is used by surgeons and the author urges larger quantities. Spinal anesthesia is better than general anesthesia in prevention of shock. Rough handling and pulling on the stomach is a fruitful source of shock. A well planned simple operative procedure cuts down the length of the operation and minimizes the danger of shock. The transverse incision described is fruitful in preventing shock.

Vomiting. This is usually due to edema at the orifice and is attributed to hypoproteinemia. If this has been adequately controlled preoperatively, vomiting is rare. Indeed, now we never use a Levine (nasal) tube and it is rarely necessary to insert one. At the first sign, however, (usually regurgitation of a mouthful of stomach contents) a Levine tube is inserted into the stomach through a nostril. Sometimes a "hidden" dilated stomach is the cause of a sudden rise in temperature. Emptying the stomach will cause a dramatic drop in the temperature. After draining the stomach for a day or two, the Levine tube is removed.

If filling occurs again, we must consider the possibility of edema at the stoma or organic obstruction by adhesions. In this case the Levine tube must be reinserted and left in. How long the case can be kept with the hope it will open up is a matter of great difference of opinion. We have repeatedly kept patients in relatively good condition for three weeks and, therefore, urge not to re-operate too hastily. We have operated upon such patients and found them well able to stand the shock. Other patients whom we feared would come to surgery made spontaneous cures. It may be stated that since the author has changed his technic to place the efferent loop of the jejunum at the greater curvature, he has had no complications of this nature.

Postoperative Hemorrhage. Again, the best treatment is prophylactic. Bleeding points in the submucous layer of the stomach are picked up and separately ligated at operation. This is particularly important in older people with sclerosed arteries. One should not rely entirely on the continuous catgut sutures to control such bleeding. When hemorrhage does occur, it manifests itself as regurgitation of black, foul-smelling material which should be immediately recognized as blood.

A Levine tube is inserted without delay and the stomach is emptied by siphonage. If a Connell suction apparatus is used, this should be lowered so that no strong suction is possible. We have seen this cause bleeding on many occasions and may be the reason for continuance of the hemorrhage. Blood transfusions not only replace the blood loss but assist coagulation by supplying thrombin, therefore, transfusions are routinely given. We have had no case in which surgery was necessary; so it is only reasonable to conclude that such is not indicated except in exceedingly rare cases. Operations under these circumstances carry a terrific mortality and must be undertaken only in those instances in which the bleeding is massive and continuous. Blood pressure taken and recorded every hour is of the utmost assistance in evaluating the severity of these cases.

It has been shown recently by Byrne M. Daly[16] that the reason thrombin given orally did not assist in stopping hemorrhage was that it is destroyed by the acid in the stomach. He recommends 60 cc. of M7 Phosphate buffer (P.H.7.8) followed by thrombin dissolved in phosphate buffer. Under these circumstances he believes that the thrombin would form a clot and assist in controlling the hemorrhage.

Pulmonary Complications. These are best treated by preventing their occurrence. Much can be accomplished along this line. Proper preparation of the patient is essential. Hypoproteinemia is an important cause of edema in the tissues and this includes the lungs. The improper administration of large amounts of fluids, especially in the aged, tends to cause overloading of the right side of the heart and decompensation ensues.

Morphine should be given at least an hour before surgery as it has been shown by Dr. Dripps[5] that the maximum effect does not take place until one hour and fifteen minutes. It should not be given in excessive doses. It is our desire to have the patient wake up quickly following surgery so that there may be active cooperation from the patient in coughing and clearing the throat of secretions. Too often the cough reflex is lacking due to oversedation following surgery.

The usual dose of atropine is insufficient. Doses of $\frac{1}{100}$ gr. to $\frac{1}{75}$ gr. more effectually controls secretion in the air passages. Haight and Rausom[6] point out that many patients suffer from postnasal drip. To prevent these and other secretions entering the trachea during operation the head should not be elevated on a pillow but should be lower than the body. Even a mild Trendelenburg position is recommended. If general anesthesia is given, an intratracheal tube should be used. At the end of the operation the bronchial tree should be sucked dry and the lungs fully expanded. It has been suggested[6] that a mixture of helium should be used for this purpose since it is less readily absorbed and tends to keep the alveoli expanded.

After the patient is brought back to bed the foot of the bed should be elevated so that secretions are expelled by dependent drainage. Even this will not properly drain the posterior part of the lungs so that the patient *must* lie a good portion of the time on his side. He must not be left too long on one side lest the secretions from the upper lung run down into the lower lung. Changing position from one side to the other at least every thirty minutes is routine in our practice.

Hypoventilation often precedes atelectasis. The lungs, therefore, should be fully expanded by urging the patient to breathe deeply. This is assisted by frequent inhalations of pure carbon dioxide. It has been suggested that inhalations of helium and oxygen would be better.[7] The bronchial plugs produce obstruction but rarely is this obstruction complete. It is thought that helium, being a lighter and more readily diffusible substance, will get past these plugs when the heavier gases will not. Steam also materially reduces the viscosity of the secretions and makes it easier to expel them. A steam kettle, therefore, should be used routinely.

The voluntary cooperation of the patient is essential. Often they are afraid to cough and must be encouraged and urged to do so even if it does cause some discomfort. Strapping the wound tightly will allow them to cough without too much discomfort.

Atelectasis may occur in spite of all these measures. It is heralded by a sudden abrupt rise of temperature. Breath sounds are coarse, but not the same as the bronchial breathing of pneumonia. X-ray of the chest usually shows a typical consolidation. It must be pointed out that a negative x-ray does not rule out atelectasis as this may be concealed by the liver shadow. We plead for careful lung examination and the *early* recognition of atelectasis. If treated promptly, the condition usually yields quickly; but if not recognized, it may soon pass into a fully developed pneumonia and

the process becomes irreversible. Often physical findings are lacking and the patient may not appear ill, but plugging of the bronchi must be suspected when there is a sudden rise of temperature. Often we use a tracheal catheter and are astounded that 30 to 40 cc. of fluid are sucked out. This procedure irritates the trachea and stimulates violent coughing. We have taught the interns and residents to pass the catheter and it is easy to learn the technic. The effect is usually dramatic and the fever drops as rapidly as it ascended.

Atelectasis in the earliest stage may be simply treated by turning the patient on his good side and provoking a coughing spell by a good slap on the back. Voluntary violent coughing may also dislodge the plugs. When this occurs, the relief is dramatic. If this fails, intubation of the trachea by a nasal tube often gives the desired relief. If this is not quickly obtained, bronchoscopy should be performed. This is a definite and effective method and rarely fails to produce the desired results. It is surprising how little shock or inconvenience is caused the patient and should not be withheld on this contention. Again we urge all the above treatment be carried out *promptly*. "Observing" the patient until the next day definitely should not be permitted.

Early Ambulation. Early ambulation is now used by us. It prevents lung complications as the patient can cough when standing and is urged to do so. The patient can also urinate better and cystitis and pyelitis are prevented. He is urged to get out of bed the evening of his operation if his condition permits.

Wound Infection. This complication occurs rather frequently. We now protect the wound by placing cellophane, oiled silk or rubber tissue between layers of towels. At the completion of the gastrectomy these towels are removed. The surgeon and nurses put on new gloves and new instruments are used to close the incision; infection is now a rarety.

The author has no objection to using sulfanilimide in the wound, but does not use it in the abdomen on the grounds that it is unnecessary and will produce massive adhesions.

The administration of 50,000 units of penicillin every three hours is routine. This not only guards against wound infection but is also protection against peritonitis and pneumonia.

Wound Disruption or Evisceration. When this occurs, it is indeed a serious complication and accounts for a considerable percentage of mortality. This condition will be much less frequent if sufficient vitamins, particularly vitamin C, have been administered preoperatively.[17]

Whatever the cause of evisceration, it is established that the wound will heal if held together long enough. The figure-of-eight tension sutures as ordinarily inserted are worse than useless. We have been using through-and-through sutures down to the peritoneum. These are tied over long rubber tubes in pairs on either side. Should evisceration be "attempted," these sutures may be tightened up. This obviates the necessity of putting in such sutures after evisceration has occurred. We have had no serious trouble since this technic was adopted.

Should disruption occur, however, mortality will be reduced by leaving the patient in his room and packing the wound with gauze and strapping tightly with adhesive plaster. The wound is dressed every day but the deeper gauze is not disturbed until after the fourth day. The wound heals by granulation. Taking the patient to the operating room and suturing there carries with it a high mortality. The author uses a transverse incision and has never had one eviscerate. This has materially lessened mortality.

Leakage from the Duodenal Stump. This is an extremely serious complication. It may be suspected when the patient has a sudden severe pain accompanied by shock and rigidity of the abdomen. The abdomen must immediately be opened for drainage. No attempt should be made to re-suture

the stump. Drainage by Penrose drain, with a catheter running through it, and continuous suction through the catheter maintained by a motor-driven suction apparatus, keeps the area dry and assists healing.

We have not had a leakage from the duodenum for over ten years. This is attributed to the fact that we never do a suture over a clamp and never use cautery. The open method allows the use of the Connell inversion stitch which more adequately turns the duodenum in. By this method, too, no devitalized tissue is included in the line of suture as is necessary when the clamp method is used.

Embolism and Coronary Heart Disease. In 1945 the author performed fifty partial gastrectomies. Three deaths occurred in the series. All of these were due to vascular complications. One patient died from a sudden, massive pulmonary embolus on the eighth day as he was sitting up shaving himself and otherwise feeling fine. The other two were older men who had recovered nicely and were about to go home. Both of these died suddenly from coronary thrombosis.

These occurrences make us wonder if we can put our finger on the cause and again lower mortality by its prevention. We are getting our patients out of bed earlier, sometimes as early as the first day. This will be greatly important in the prevention of thrombosis. It may be noted that much importance has been placed on water balance in preoperative and postoperative care. In the past after the patient was taking increased amounts of fluids by mouth, we rested on our oars and did not realize that again the patient became dehydrated, leading to increased concentration and viscosity of the blood. Repeated hematocrit readings should be done and dehydration prevented. We now use glucose and blood much longer in the postoperative course than previously and believe we will be rewarded by a lower incidence of heart and blood vessel thrombosis and embolism. We have not been using the anticoagulants except after thrombosis; perhaps we should.

When we are given some warning, such as deep-seated pain in the leg, we may fear embolism. Daily examination for this and Homan's sign should be tested for. Whether we should rush in and ligate the femoral vein when this sign is positive is a moot question. It has been our experience that deaths usually occur from unheralded massive emboli.

When thrombophlebitis and phlebothrombosis occur, we have had most gratifying results following the use of heparin, dicumeral and penicillin. Our results by conservative methods are so gratifying that immediate surgery in all cases seems too radical a procedure.

SUMMARY

The author has performed 600 partial gastrectomies. A high mortality in the earlier cases has now been reduced to 2.5 per cent. As many as sixty consecutive gastrectomies have been performed with no mortality. Close attention to preoperative preparation is essential. A well planned, simplified operation has been described. This allows rapidity and reduces shock. A transverse incision is urged to prevent evisceration and to give good exposure.

The author wishes to emphasize the early recognition and treatment of lung complications, embolism and coronary thrombosis. These are also discussed and suggestions made for their reduction.

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A. D. Ochkin of Russia followed up 102 cases of gastrointestinal cancer and summarizes his findings and recommendations: For cancer of the stomach a palliative gastrojejunostomy or a simple jejunostomy for feeding purposes seems well worth while. Patients were made more comfortable and lived an average of two months to four months longer. Radiotherapy may be attempted as a supplementary measure but one must not expect many of these growths to be radiosensitive. Life is often prolonged considerably by palliative surgery and a fixed growth, formerly considered inoperable, often becomes smaller and mobile so that surgery, later, becomes possible. For all of these reasons the author believes that palliative surgery for advanced cases of cancer in the gastrointestinal tract as well as in the head of the pancreas are well worth doing. (*Richard A. Leonardo, M.D.*)

GASTROJEJUNOCOLIC FISTULA*

ARKELL M. VAUGHN, M.D., L. C. HOLLISTER, M.D. AND F. A. LAGORIO, JR., M.D.
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A GASTROJEJUNOCOLIC fistula is an abnormal opening connecting the stomach, jejunum and colon, thus allowing ingested food to pass directly from the stomach into the colon, and in turn also allowing fecal contamination of the stomach and small bowel. The irritating presence of feces in the upper gastrointestinal tract produces a vicious diarrhea which leads to dehydration, anemia and further impairment of digestion and absorption. This condition may be seen as a complication of gastric cancer or more rarely as a complication of chronic ulcerative colitis.[1]

Etiology. Glickman[2] has stated that the causes of gastrocolic fistulas before the widespread use of gastro-enterostomy were, in order of frequency: cancer, ulcer, abscess in the peritoneal cavity, tuberculosis and congenital anomaly. Bornstein and Weinshel[3] present a very inclusive list of secondary and precipitating factors, stating that a gastrojejunal ulcer, and primarily a duodenal ulcer, is responsible for the formation of a gastrojejunocolic fistula, and that factors precipitating the marginal ulcer are (1) focal infection, trauma, tuberculosis or syphilis; (2) marked hyperacidity, inasmuch as the jejunum which is accustomed to an alkaline medium is now exposed to an acid one, as shown by the experiments of Mann and Williamson;[4] (3) operative trauma to the mucosa from the improper use of clamps; (4) use of nonabsorbable sutures and Murphy buttons; (5) foreign body inclusions; (6) indiscretion in diet too soon after surgery; (7) carelessness in medical supervision; (8) excessive smoking, alcoholism and use of condiments; (9) fatigue or exposure; (10) arteriosclerosis; (11) resolution of hematomas; (12) faulty surgical technic, e.g., placing the anastomosis too high, and (13) the same causes which produced the original ulcer.

Pathology. A gastrojejunocolic fistula usually connects the jejunum with the transverse colon; rarely does the stomach connect directly with the colon. The fistula is usually existent close to the anastomosis and generally inferior to it and is located on the distal loop of the jejunum. The fistulous tract is lined with smooth, glistening mucous membrane, while the mucosa of the surrounding tissue (gastric, jejunal and colonic) may show evidence of marked inflammation.

Symptomatology. The outstanding symptom of a gastrojejunocolic fistula is diarrhea. The stool is watery, semisolid, fatty and generally contains many undigested food particles. It has a pungent, foul odor and fails to respond to the usual medical treatment. It is acid in reaction due to the admixture of gastric secretions. Pfeiffer[5] attributes the diarrhea and chemical imbalance in these cases to the regurgitation of colonic material into the upper gastrointestinal tract causing rapid peristalsis throughout the small intestine with little or no absorption of food.

There is marked emaciation, weakness and dehydration if the condition has existed for any length of time. Eructation of a stercorous smelling gas is another of the more aggravating symptoms, and the administration of enemas will increase the frequency and degree of this condition. Vomiting is frequently present and is usually fecal in nature. This is increased by large enemas and decreased by frequent

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gastric lavage and administration of a constipating diet. In the absence of intestinal obstruction, Bornstein and Weinshel[3] believe that fecal vomiting is pathognomonic of gastrojejunocolic fistula. There is always weight loss which is generally marked and rapid in onset. Anorexia is usual although occasionally there is an unimpaired or increased appetite and intake of food. Abdominal pain to the left and below the umbilicus may or may not be present and, if present, may cease after the formation of the fistula. The patient generally shows some degree of anemia which is generally due to the failure to absorb iron or else the inability to absorb the anti-anemic factor of Castle. Atwater, Butt and Priestley[6] found in reviewing their series of thirty-nine cases that 14 per cent of these patients showed a macrocytic type of anemia. Hemorrhage may be present during the existence of the marginal ulcer and persists following the formation of the fistulous tract. A low serum protein is generally present in patients who have suffered for some time with the disease and may be manifested by a nutritional edema.

Diagnosis. The diagnosis of this condition is based upon a history of previous peptic ulcer which had been treated surgically by gastro-enterostomy which had afforded temporary relief. This is followed by a period of abdominal discomfort or pain, nausea, vomiting or hemorrhage which in turn is followed by diarrhea, stercorous eructation, weight loss and cachexia.

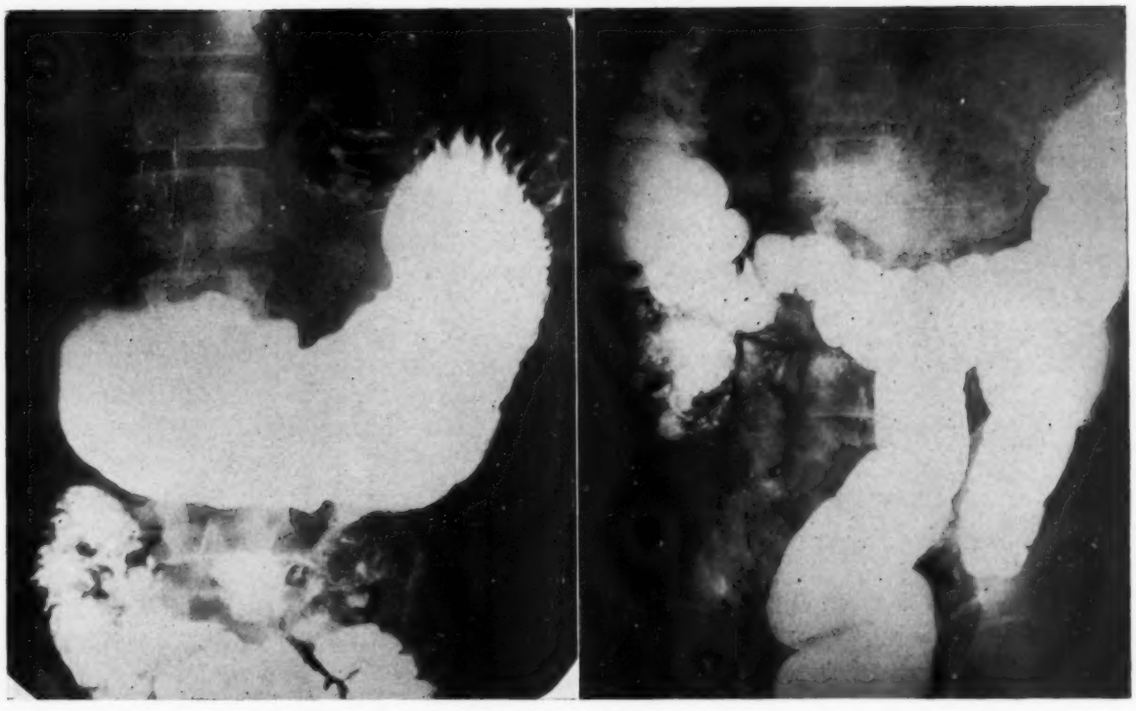
Physical examination of the patient may prove negative except for malnutrition, apparent anemia and the presence of an abdominal scar. A mass is seldom felt and, if present, is due to adhesions or a regional inflammation. Examination of the stool may reveal blood, occult or fresh, and may also reveal many undigested food particles. The employment of dyes either rectally or orally, and their recovery by gastric lavage or enema, may be helpful in the determination of the presence of a fistula. Roentgenologic examination with barium medium showing direct passage between the stomach, jejunum and colon establishes the diagnosis with a certainty. However, both a barium meal and enema should be employed.

Prognosis and Mortality. The prognosis of a patient suffering from a gastrojejunocolic fistula must always be considered grave and, without surgical intervention, the course is one of continued malnutrition and emaciation which usually results fatally. The operative mortality varies considerably. Marshall[7] reports an operative mortality of 7.1 per cent occurring in the surgical treatment of fourteen patients. Pfeiffer[5] reports a mortality of 6.6 per cent; Ransom[8] 14 per cent; while other reports in the literature show varying percentages up to 63 per cent.

Treatment. The treatment of these patients is primarily surgical but the preoperative care necessary to bring them up to a somewhat normal level is most adequately handled as reported by Gray and Sharpe.[9] Many different surgical technics have been employed in the treatment of this condition, and the method of choice seems to be that which is applicable to the pathological condition found at operation.

Evans and Skinner[10] state that in instances of extensive induration and adhesion formation, resection *en bloc* may be the only procedure. Findlay[11] has advocated using the Mikulicz procedure in a multiple-stage operation exteriorizing the colon and attached jejunal stump. Finsterer[12] preferred a one-stage operation but states that a two-stage operation is indicated in those individuals in whom a simple closure of the fistula is impossible because of its size. Pfeiffer[13] advises a preliminary proximal loop colostomy with jejunostomy.

Lahey and Swinton[14] and also Marshall[7] advocate a technic whereby the terminal ileum as a preliminary measure is cut across, the distal end closed and the proximal end anastomosed to the descending colon as a first-stage procedure. Then at the end of two weeks the ascending colon,



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FIGS. 1 and 2. Case 1. Roentgenograms taken January 8, 1945, before surgery. In Figure 1 barium meal reveals gastro-enterostomy and defect of cap. Figure 2 is a roentgenogram taken five hours after barium meal. Note (1) barium in stomach; (2) barium in transverse colon; (3) barium in distal ileum; (4) absence of barium in cecum and ascending colon.

the remaining terminal ileum, the fistula, the jejunum and the portion of the stomach to be resected are removed *en bloc*, and the end of the transverse colon distal to the fistula closed, with the fecal stream already diverted and established. The jejunum is reunited by an end-to-end anastomosis and then anastomosed to the resected stomach.

CASE REPORTS

CASE 1. Mr. W. C. entered Mercy Hospital February 10, 1945. His chief complaint was epigastric pain, radiating to the back, coming on two to three hours after eating and relieved by vomiting, ingestion of food or alkalies, which had been present for the past twenty years, during which time he had been on peptic ulcer management by Sippy powders and diet. Early in 1938 he developed symptoms of obstruction. He would generally vomit after the second meal of the day and the vomitus would consist of undigested food. No blood was ever noted. His diet was changed to softer foods and soon only liquids were tolerated. This relieved the patient of vomiting to some degree but he suffered a weight loss of 40 pounds over a six months' period. In March 1938 the patient underwent surgery and a posterior gastro-enterostomy was performed. He did fairly well on a modified diet for the ensuing year.

In March 1939 he had an attack of severe pain generalized throughout the abdomen with greater intensity in the right upper quadrant. The right side of the abdomen was exquisitely tender but there was no radiation to the right shoulder. Treatment was symptomatic with five weeks of bed-rest. His symptoms gradually subsided. He gained in general health and weight although still experiencing attacks of vomiting.

General good health was maintained until November, 1944, when he began to notice an increasing amount of fatigue, more frequent attacks of vomiting and a progressive weight loss, totaling 30 pounds over a three months' period. The month preceding admission to the hospital he noticed that food recently eaten would be passed in the bowel movement in a short time practically unchanged. During this time he had an insatiable appetite and thirst, but experienced diarrhea and occasional vomiting.

The x-ray examination revealed (Fig. 1) filling of stomach with passage of barium through old gastroenterostomy into jejunum but also passage of barium into large bowel. A barium enema (Fig. 2) showed filling of large bowel with passage of barium into stomach and small bowel.

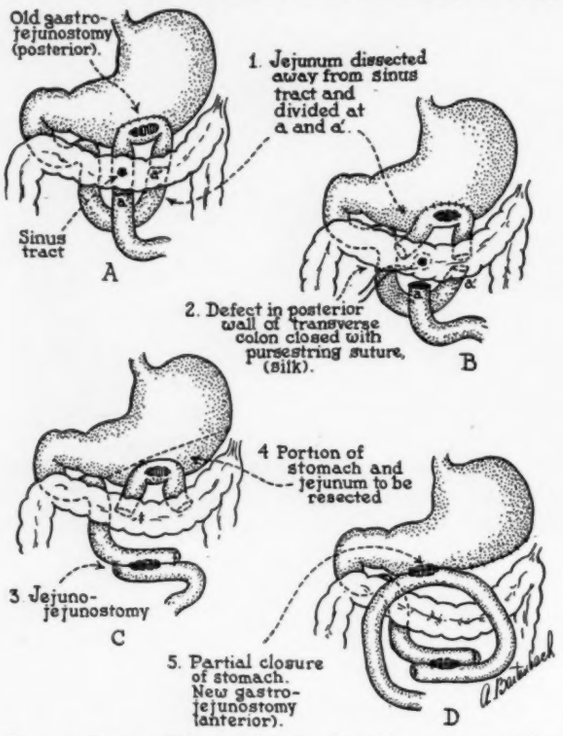

Old gastro-jejunostomy (posterior).
Sinus tract
A
1. Jejunum dissected away from sinus tract and divided at a and a'.
2. Defect in posterior wall of transverse colon closed with purse-string suture, (Silk).
B
4 Portion of stomach and jejunum to be resected
3 Jejuno-jejunostomy
C
5. Partial closure of stomach. New gastro-jejunostomy (anterior).
D

FIG. 3. Case 1. Diagrammatic sketches A, B, C and D showing steps in the repair of a gastrojejunocolic fistula. A modified Lahey anterior gastro-enterostomy is shown. A gastric resection instead of the gastro-enterostomy is usually the procedure of choice.

The conclusion arrived at was gastro-entero-coli fistula.

The laboratory work-up revealed no apparent anemia due to dehydration; serum protein 4.42. Preoperatively the patient was placed on sulfasuxadine, high caloric diet, multi-vitamins and blood and protein replacement therapy.

On February 19, 1945, under spinal anesthesia the patient underwent surgery for repair of the gastro-enterocolic fistula. The following steps were done: (1) Closure of the fistula in the transverse colon by a purse-string silk suture, superimposed by interrupted silk mattress sutures (Fig. 3B); (2) resection of the jejunum proximal and distal to the fistula with a lateral anastomosis of the remaining jejunum (Fig. 3C); (3) resection of a portion of the greater curvature of the stomach with the former gastro-enterostomy stoma and attached jejunal segment, including jejunal ulcer (Fig. 3C); (4) anterior gastro-enterostomy of jejunum distal to site of lateral anastomosis, and to distal end of greater curvature of the stomach—Lahey anterior gastro-enterostomy. (Fig. 3D.)

His postoperative course was not remarkable and he was discharged on the twenty-first postoperative day.

X-rays taken six months postoperatively revealed (1) after a barium enema (Fig. 4) a normal large bowel; after a barium meal (Fig. 5) a functioning gastro-enterostomy. The laboratory findings eight months postoperatively showed red blood count 4,390,000, hemoglobin 12.3 Gm., serum protein 6.0. Gastric analysis one year postoperatively showed free hydrochloric acid 28°, total acid 36°; no blood present.

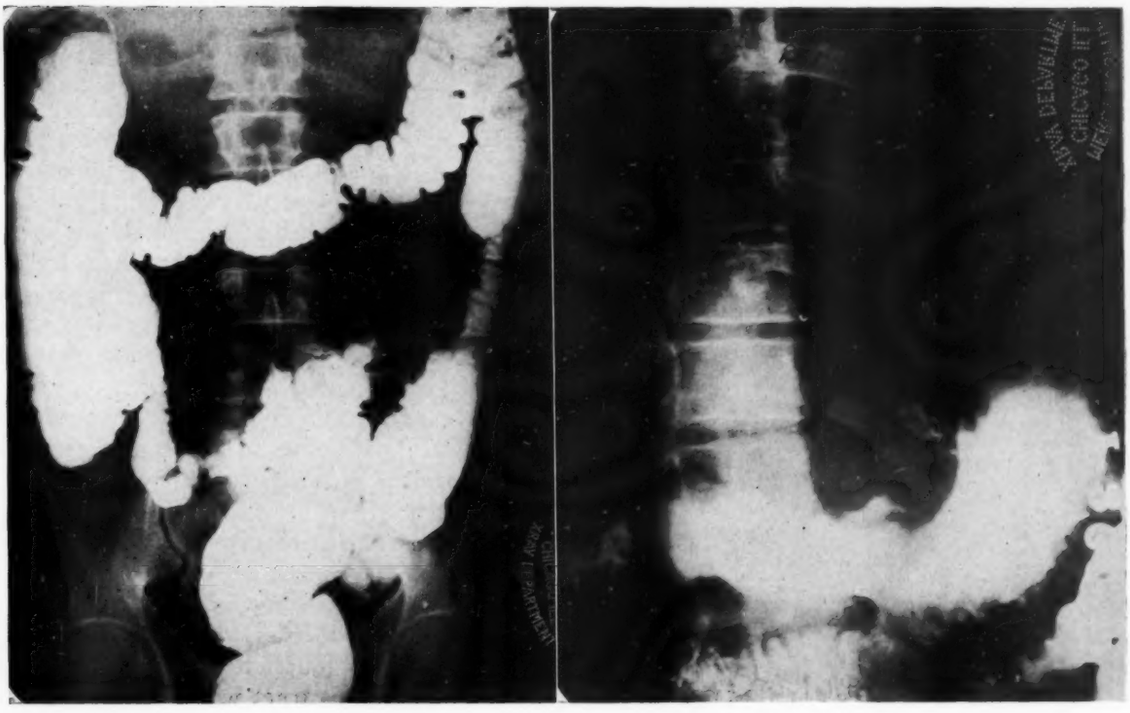
At the present time he weighs 185 pounds while weighing only 130 pounds at the time of surgery. He is now working daily at his trade.

CASE II. Mr. R. B., aged forty, entered Mercy Hospital on December 3, 1946, complaining of nausea, vomiting, diarrhea, weight loss and generalized colicky abdominal pains which had been present for the past year. The following past history was obtained:

In August, 1940, the patient was operated upon and hospitalized for twenty-one days in a Chicago hospital with a diagnosis of a ruptured peptic ulcer. His postoperative course was uneventful except that following his release from the hospital he was unable to tolerate food and had a feeling of epigastric fulness.

In May, 1941, he suffered a second perforation of a peptic ulcer and following celiotomy was informed that, besides the ruptured ulcer, he also had a "bowel obstruction" and that a posterior gastro-enterostomy had been done. His postoperative course was uneventful except that his wound failed to heal, and he was discharged from the hospital twenty-eight days later with an open skin wound which healed three months following discharge. Subsequently an incisional hernia had developed. This hernia was repaired in November, 1943, and he returned to work as an electrician six months later.

While at work in the summer of 1944, he was accidentally struck in the abdomen by a wrench. This was followed by sharp, colicky pains in the upper abdomen, associated with nausea. He was also aware of a swelling in the



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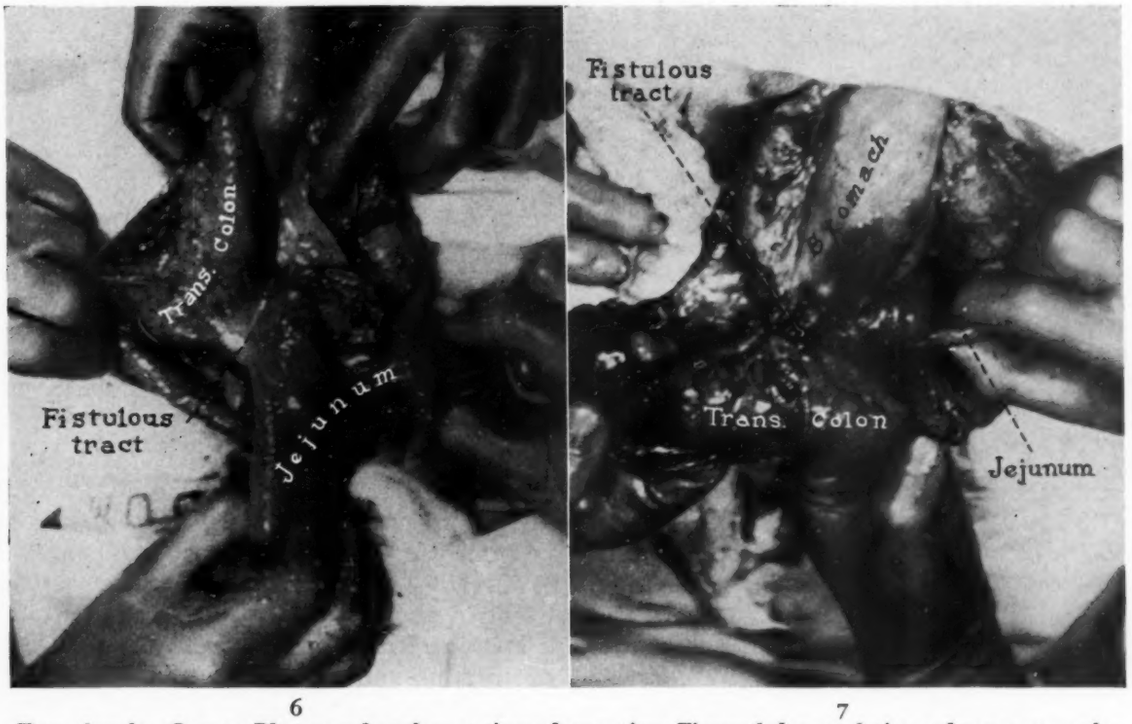
FIGS. 4 and 5. Case 1. Roentgenograms taken October 8, 1945, after surgery. In Figure 4 note that there is no reflux into stomach and normal lumen of bowel on barium enema study. Figure 5 shows diminished size of stomach and new gastro-enterostomy.



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FIGS. 6 and 7. Case 11. Photographs taken at time of operation; Figure 6 shows relations of transverse colon (which is retracted upward), stomach and jejunum. Note absence of adhesions or inflammatory reaction. Figure 7 reveals relations of transverse colon (which is retracted downward), stomach and jejunum.

region of his incision and was again hospitalized and a large abscess was drained. He was discharged in nine days but a purulent drainage continued for the next year. The patient returned to work six months following incision and drainage of the abscess, but he now complained of fatigue and night sweats.

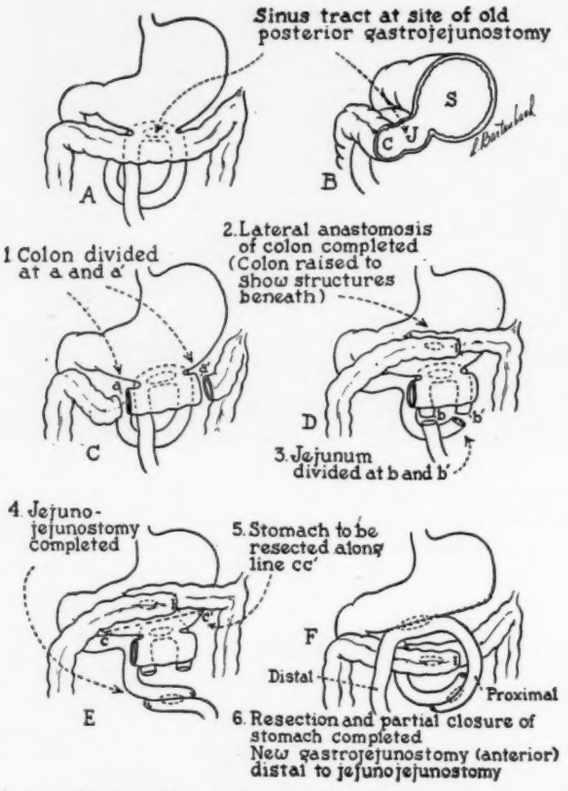

FIG. 8. Case II. Diagrammatic sketches A, B, C, D, E and F showing steps in the repair of a gastrojejunocolic fistula. A modified Lahey anterior gastro-enterostomy is shown. End-to-end anastomosis of the transverse colon and of the jejunum is quicker but it is a matter of opinion as to whether end-to-end or lateral anastomosis should be used.

In November, 1945, he had a sudden onset of epigastric pain accompanied by nausea, vomiting and diarrhea. His stools at this time were at first tinged with bright red blood and later became tar-colored. He was again hospitalized for twenty-eight days during which time he was placed on Lextron and a bland diet. Upon discharge he was without symptoms.

In March, 1946, the patient suffered another remission with nausea, vomiting and bloody diarrhea. Since that time he had frequent attacks of nausea and belching which he described as fecal smelling and tasting. He also had spontaneous attacks of vomiting and stated that the vomitus looked, smelled and tasted like feces. He had been having four to six loose, watery stools daily and at times noticed undigested food particles in his feces. He had lost 20 pounds in weight during the past year; his original weight was 136 and his admission weight was 116 pounds. He stated that his appetite was excellent and he could not understand why he had been unable to gain weight and control the diarrhea.

Laboratory findings on admission revealed red blood cells 4,000,000, hemoglobin 12.59 Gm. (81 per cent), total protein 4.62. Preoperative x-rays were poor due to extreme discomfort of the patient. Preoperative care consisted of a high caloric diet. mult-vitamins, blood and protein replacement therapy.

The operative procedure was performed with fractional spinal anesthesia. A left upper rectus muscle splitting incision was made and the peritoneal cavity found to be free from adhesions. The fistulous tract was easily found and was free of any dense adhesions or inflammatory reactions. (Figs. 6 and 7.) The fistulous tract was of a large diameter. (Fig. 8A and B). Due to the large size of the tract it was obvious that extensive resections had to be employed. The jejunum proximal and distal to the tract was resected and united by lateral anastomosis. (Fig. 8D and E.) The greater curvature of the stomach bearing the fistula and the remnant of the former gastro-enterostomy was then resected. (Fig. 8E.) Following this, the portion of the transverse colon involved in the fistula was also resected and reunited by lateral anastomosis. (Fig. 8C and D.) This was followed by an anterior gastro-enterostomy of the Lahey type, and the portion of the jejunum distal to the site of the previous lateral anastomosis was used for the anastomosis between the jejunum and the greater curvature of the stomach. (Fig. 8F.)

The patient's postoperative course was not remarkable and he left the hospital on the forty-third postoperative day. His stay in the hospital was greatly lengthened by a problem of Social Service disposition since he was unemployed.

Postoperative x-rays showed the following: After a barium meal (Fig. 9) a functioning gastro-enterostomy; after a barium enema a normal appearing colon with evidence of anastomosis in the transverse colon.

At the time of discharge his weight was 135 pounds while at the time of surgery it was 115 pounds.

FIG. 9. Case 11. Roentgenogram taken five hours after the meal shows small amount of barium still in the stomach and duodenal cap. The remainder of meal is irregularly scattered throughout the small bowel and colon. The bowel shows typical cobblestone appearance of vitamin deficiency; x-ray also shows a functioning gastro-enterostomy.

COMMENTS

The management of gastrojejunocolic fistula is one of surgical necessity, but the proper preoperative management of these patients cannot be stressed too greatly. Today with our increased knowledge of nitrogen balance and intravenous corrective therapy, these patients usually can be brought to surgery in optimum condition.

Since the advent of sulfa drugs, penicillin, plasma and extensive employment of whole blood, in addition to improved technic in anesthesia, especially spinal, the operative procedure can usually be performed in one stage.

In the presence of marked inflammation about the site of the disorder, we can readily understand the value of a preliminary colostomy as advocated by Pfeiffer and Kent.[13]

Resection of the fistula *en bloc* followed by a subtotal gastric resection and re-establishment of the gastrointestinal continuity is the procedure of choice. This procedure should reduce the gastric acidity sufficiently to prevent the recurrence of a marginal ulcer.

Since the operation is one of great magnitude, usually requiring several hours and associated with a high operative mortality, an anterior Lahey type of gastro-enterostomy can be used to re-establish the gastrointestinal continuity, lessen the operative time and thus lower the mortality. For the above mentioned reasons this procedure was carried out in the two cases herein reported. In the patient of older age with a low gastric acidity the possibility of a future recurrence of a marginal ulcer must be weighed against the possibility of an operative mortality. We chose the first alternative, fully realizing that a subtotal gastrectomy was theoretically the operation of choice. Likewise, our choice in the use of a lateral anastomosis was one of confidence in personal surgical technic.

Recently in view of the work done by Dragstedt[15] and his associates upon the effects of the vagus nerves on gastric secretion, motility and acidity, we believe that another beneficial procedure has been placed in the hands of the surgeons for the treatment of marginal ulcers and for the prophylaxis of gastrointestinal ulceration by means of section of the vagus nerves. Since the patient in Case 11 had experienced two previous peptic ulcer perforations and developed a jejunal ulcer with resultant perforation into the transverse colon, we believe that he is a candidate for future gastrointestinal ulceration and should be followed very closely. In the event that such a condition arises, we are of the opinion that supradiaphragmatic section of the vague nerves is the procedure of choice; and the patient, being well aware of his ulcer tendency, has already agreed to

this procedure if at any time we think it advisable. However, two and one-half years have elapsed without further symptoms and the gastric acidity is still within normal range.

CONCLUSIONS

1. Two successful one-stage operations for gastrojejunocolic fistula are reported.

2. A partial review of the literature is presented.

3. Improved methods of anesthesia are an aid in permitting this operation to be done in one stage.

4. Pre- and postoperative care is directed toward the correction of imbalanced physiology.

5. The Lahey anterior gastro-enterostomy was used successfully in both cases.

6. A macrocytic type of anemia was not present in either case.

7. Both cases occurred in males whose average age was forty-four years.

8. The marginal ulcer, with subsequent fistula formation, followed previous posterior gastro-enterostomies.

9. In Case I the fistula developed six and one-half years following formation of the marginal ulcer, while in Case II the time interval was four months.

10. Four years and two and one-half years, respectively, have elapsed since surgery with no recurrence of symptoms.

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Case Reports

CYSTADENOMA OF THE PANCREAS

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TRUE cysts of the pancreas, while rare enough to stimulate our enthusiasm for accurate diagnosis and to arouse our interest in the most proficient manner of treatment, are more common than a perusal of the literature would lead one to believe.

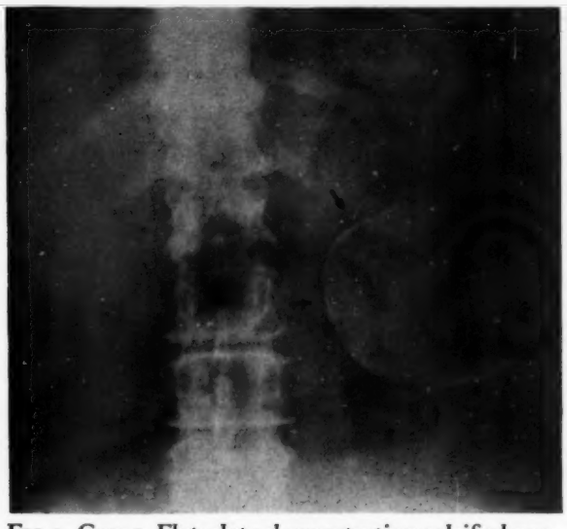


FIG. 1. Case 1. Flat plate demonstrating calcified pancreatic cystadenoma.

True cystadenomas, springing from the tail of the pancreas, were diagnosed preoperatively in both cases reported herein. Both cystadenomas gave surprisingly little discomfort or symptoms and both were amenable to complete extirpation.

CASE REPORTS

CASE 1. L. D'A., Case No. 168047, fifty-four years of age, was admitted to the Jewish Hospital on October 21, 1940, complaining of pain in the epigastrium. For several months preceding admission she had a "feeling of fullness" in the upper left quadrant of the abdomen. She had not vomited. Her bowel habits were regular; her general health had always been good. There were no urinary symptoms or loss of weight. There was no history of trauma or of any parasitic infection. Physical examination was essentially negative except for the presence of a smooth, rounded mass the size of an orange in the upper left quadrant of the abdomen. The mass was not mobile from side-to-side but moved up and down with respiration. The fasting blood sugar ranged from 90 to 130 mg. per 100 cc. The blood urea nitrogen was 15.5 mg. per 100 cc. Blood amylase calculation was not done. The flat plate x-ray (Fig. 1) showed a large calcified cyst. The preoperative diagnosis was cyst at the tail of the pancreas.

FIG. 2. Case 1. Photograph of specimen removed from patient.

Operation was performed on October 22, 1940, under spinal anesthesia. An upper left rectus incision was made. The tumor mass was most prominent between the stomach and

FIG. 3

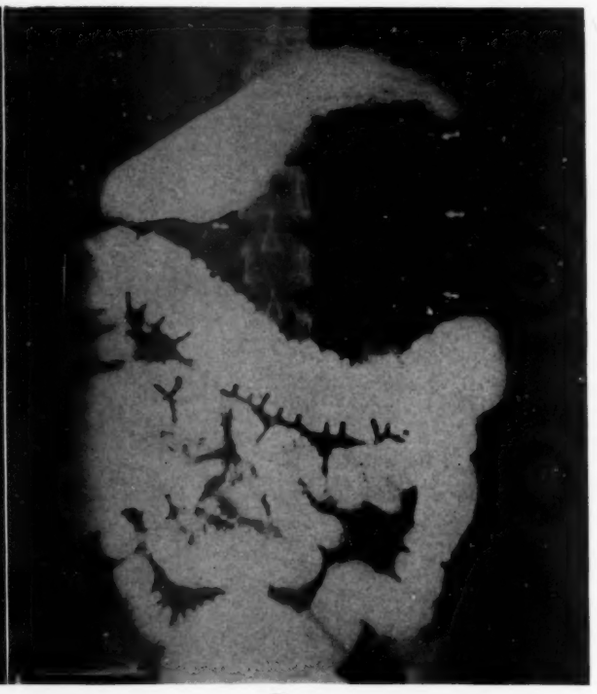


FIG. 4

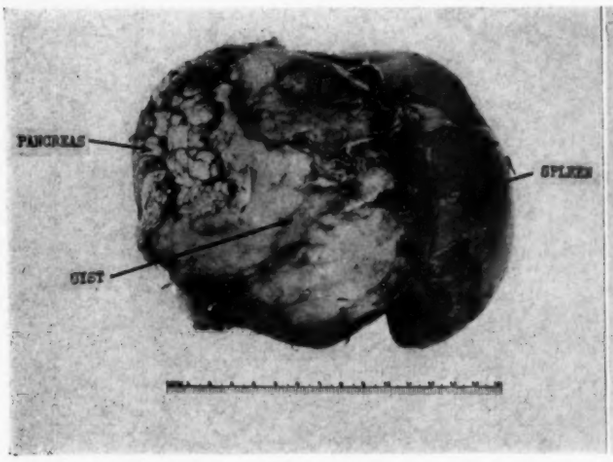
FIG. 3. Case II. X-ray showing typical pressure deformity of the stomach.
FIG. 4. Case II. X-ray showing displacement of the stomach upward and the transverse colon downward.

transverse colon. Accordingly, the gastric colic omentum was opened in an avascular area, the colon being mobilized downward and the cyst exposed. Extirpation was decided upon as the method of choice and was accomplished by sharp dissection until a plane of cleavage was obtained. It was easy to enucleate the cyst by blunt dissection with the finger down to its rather broad base in the tail of the pancreas. A small piece of the pancreas was excised with the cyst. (Fig. 2.) The wound in the pancreas was closed with interrupted sutures of linen thread. The rent in the mesocolon was closed and the abdomen was closed without drainage.

The patient made an uneventful recovery and was discharged from the hospital on the eleventh postoperative day. Follow-up information was obtained from her family physician who reported her well and symptom-free one, three and five years after operation.

The specimen consisted of a portion of pancreas measuring 1½ cm. in length and a pancreatic cyst measuring 8½ cm. in diameter. The surface was irregular and hard in consistency. On cross section it consisted of a unilocular cyst the lining of which was thin and calcified and filled with amorphous, chocolate material. Section of tissue showed a large number of acini and pancreatic tissue lined by cuboidal cells arranged in cluster formation. The nuclei resulted on a basement membrane. There was pronounced hyperplasia of the islands of Langerhans. There was a numerical increase in the number of islands as well as an increase in the size of individual islands. There was no evidence of malignancy. The diagnosis was cystadenoma of the pancreas.

CASE II. M. W., Case No. 5263, thirty-six years of age, was referred to our service at St. Joseph's Hospital on December 15, 1946, complaining of cramp-like pains and a sense of fullness in the upper left quadrant of the abdomen. For the past year she had had pains after eating. There was no history of vomiting or change of bowel habits and no urinary symptoms. She had lost 10 pounds in the past year but this may have been by purposeful dieting. She had two children. Menstruation was regular. There was no history of abdominal trauma and physical examination was essentially negative except for the abdominal portion. Filling the entire upper left quadrant was a large, smooth, rounded mass, the size of a basketball. The spleen could not be palpated separately. The mass was fixed; it could not be moved from side-to-side and did not move with respiration. Vaginal examination was negative. X-ray studies before admission to the hospital showed the presence



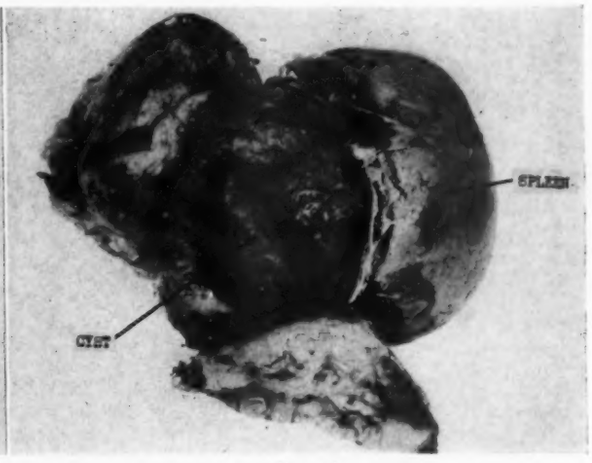


FIG. 5 FIG. 6

FIG. 5. Case 11. Photograph showing specimen of the cyst with spleen attached and portion of the pancreas.
FIG. 6. The same as Figure 5 showing the cyst opened.

of a tumor between the stomach and colon. (Figs. 3 and 4.) On admission the patient's blood count was within normal limits, blood sugar 123 mg. per 100 cc. and blood urea 9.6 mg. per 100 cc. The laboratory reported a blood amylase of 1,600 units. (The figure is so high that we question the accuracy of this determination.)

Operation was performed on December 18, 1946, under fractional spinal anesthesia. The abdomen was opened by an upper left rectus incision. An enormous cyst, springing from the pancreas, was between the stomach and transverse colon. For complete extirpation more room was needed than could be obtained through the gastrocolic omentum. Consequently, an indirect approach was made by turning the transverse colon and great omentum upward and opening the transverse mesocolon in an avascular area, with due regard for the middle colic artery. With great difficulty, a plane of cleavage was found after careful separation of the adhesions. Once the correct plane of cleavage was established it was easy to enucleate the cyst by blunt dissection with a finger and occasional sharp knife dissection. The splenic artery and vein were so incorporated in the cyst wall that we decided to remove the spleen with the cyst. Apparently the spleen had not been functioning properly for some time due to pressure on its vessels. This is assumed because we noted and carefully left four accessory spleens about the size of large cherries. Hemostatis was troublesome. Oozing from the cyst bed was controlled by gelofoam gauze. The rent in the mesocolon was closed around a small, soft rubber drain.

Convalescence was entirely uneventful. The patient was out of bed the following day and left the hospital on the tenth postoperative day. Four months after operation her family physician reported that she was entirely well and symptom-free except for hepatitis with jaundice which occurred two months after operation and lasted two weeks. This we attribute to the plasma or blood which she received during the operation.

The specimen (Figs. 5 and 6) consisted of the spleen measuring 14 by 6 by 6 cm. with a large cyst measuring 14 cm. in diameter intimately attached throughout its length. The cyst wall was 2 to 4 cm. thick. It was fibrous, multiloculated and contained chocolate-colored mucus-like material. Sections of the cyst wall showed characteristic epithelium with a single row of tall columnar cells with basely situated nuclei. In some regions the epithelium was papillary in formation but nowhere was there more than one layer of cells seen. The underlying subepithelial tissue was fibrous. The diagnosis was benign multiloculated papillary cystadenoma.

Pascucci[1] gives the incidence of pancreatic cysts as 0.061 per cent. Brunschwig differentiates between true cysts and cystadenomas. He states that the latter are more solid in consistency without free communication between the loculations of the cyst and that they rest in the pancre-

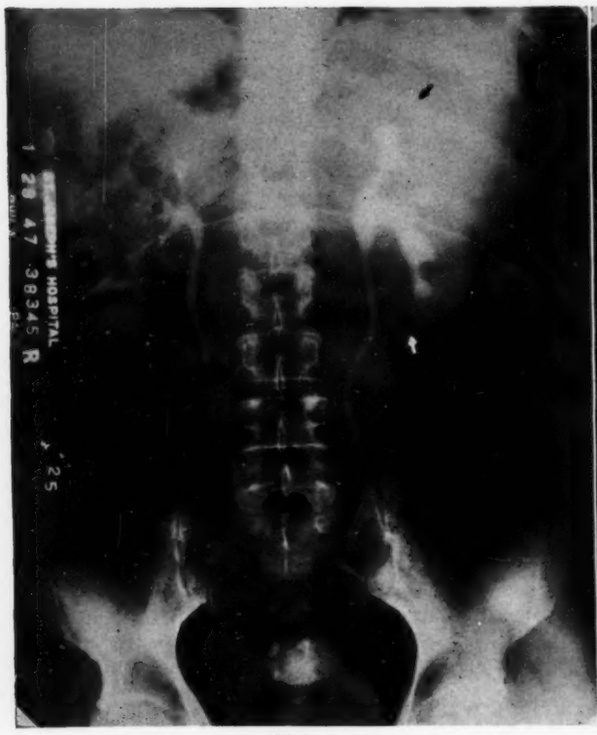


FIG. 7

FIG. 8

FIG. 7. Intravenous urography showing normal kidney outline and large cyst, filling the left hypochondrium.
FIG. 8. X-ray, same case as Figure 7, showing typical gastric deformity and displacement of the intestine to the right.

atic bed rather than protrude from it by a pedicle. It seems to us that the final decision must rest with the pathologist and must be based on his microscopy of the cyst wall. We conceive that the consistency and intercommunication of the multilocular cyst is merely a progressive picture of pressure, hemorrhage and breakdown of its contents.

Attempts at calcification of true cysts of the pancreas have been made by almost all authors. Pascucci, Thigpen, Kaufman, Johnson,[2] Pinkhan and others each has his own differentiation. It is of little moment except to separate the so-called pseudocysts which are not cysts at all but collections of old inflammatory processes. True cysts which constitute a distinct clinical entity are either neoplastic in origin or retention cysts. A congenital cyst, for example, could be of either variety but should not be considered as a separate entity. To be unnecessarily precise regarding their classification is unproductive and foolish.

Judd, Mattson and Mahorner[3] and many others have laid stress by diagram and description on the location of the cysts describing them as between the stomach and the colon, beneath the liver, beneath the colon, etc. We contend this is as antiquated as a discussion of the coverings of a hernia. It is obvious that a cyst in its growth and development takes the line of least resistance. It is unimportant where it becomes most superficial. In its removal access to it will be obtained in the most convenient, safe approach that affords the most ease of manipulation.

SYMPTOMS

Symptoms produced by pancreatic cysts are symptoms of pressure. No signs or symptoms are peculiar to the lesions. Walter and Cleveland[4] state that 95 per cent of their patients had pain. Most writers mention such symptoms as cachectic state, loss of appetite and weight loss. These result from pressure on the stomach. In like manner, constipation results from

pressure on the colon. Glycosuria and steatorrhea, depending on pancreatic deficiency, are always alluded to at this time. Their presence would indicate either destruction of a goodly amount of the pancreas or interference with its function. In the two cases reported herein both patients had only one prominent symptom in the presence of major lesions, namely, a "sense of fullness" in the upper abdomen. Physical examination revealed an obvious mass in the upper left quadrant.

The differential diagnosis must be contemplated for malignant tumors, aneurysms, retroperitoneal growths, gallbladder disorders with distention and, most particularly, renal cysts or neoplasms and splenomegalies. X-ray examinations should include complete gastrointestinal study including barium enemas and intravenous urography.[5] Figure 7 shows an intravenous urography study with a normal kidney outline overlapped by, but differentiated from, the cyst. It is unbelievable how large a growth may be symptom-free. Figures 7 and 8 show the x-ray findings in M. L., Case No. 282, sixty-five years of age, whom we saw in consultation in January, 1947, at St. Joseph's Hospital. He had a cystic mass the size and shape of a football which extended from the ribs to the umbilicus on the left side of the abdomen. From physical examination and x-ray findings we were convinced that he had a large pancreatic cyst but the patient felt so well that both he and his physician refused operation.

It is surprising how little has been added to our store of knowledge concerning pancreatic cysts in the past twenty years. Moynihan[6] wrote a masterful chapter on pancreatic cysts, and Brunschwig[7] wrote an equally enlightening monograph. However, excluding the advances in surgical technic, practically nothing has been added in the intervening sixteen years.

TREATMENT

Once the abdomen is opened and the lesion is identified, three procedures are available: internal drainage, marsupialization or extirpation. No one will deny that the theoretic method of choice is excision. Internal drainage,[8–12] while ingenious, is not physiologic and at times has proved completely unsatisfactory. Marsupialization with obliteration of the sac by packing has been reported as good in the literature. Judd and others report excellent results. We have had no experience with this procedure but have observed several cases in the hands of our colleagues, with unhappy results. Brunschwig, in speaking of the indications for excision, states that the tumor must not be of excessive size, should be fairly mobile and free of numerous and dense adhesions. We challenge this dictum because had we followed it, neither patient would have been considered for excision. With a careful, deliberate, anatomic approach, anticipating essential structures and vessels and guarding against their injury, a plane of cleavage should be sought. Once this is established a cyst which seems to have insurmountable obstacles to its removal can be shelled out with ease. An attempt should be made to remove the lesion in every case. No harm will be done if due care is taken. If removal is impossible, one of the less advantageous methods can be used to terminate the operation. The absorbable hemostatic gauze was most helpful to us and its use should be borne in mind.

We believe that in dealing with this condition most of us are only "occasional operators" and hesitate to report on our meager experience. This causes true pancreatic cysts to appear to be less common than is actually the case. In like manner, only the more favorable results from the larger and better clinics appear in the literature.

CONCLUSIONS

1. True pancreatic cysts, while rare, are more common than the literature indicates.
2. Too much emphasis has been placed on impractical classifications.

3. Cases are presented to show the simplicity of diagnosis with roentgenologic aid.

4. In the light of improved surgical technic and anesthesia a plea is made for removal of the cyst rather than exteriorization or internal drainage.

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Paxton and Payne studied the records of over 300 patients with acute pancreatitis and found that the patients operated upon had a mortality of about 45 per cent, whereas it was less than half as high for the patients treated medically. If the diagnosis is definite, I am sure the average surgeon also prefers conservative treatment. The authors stress the importance of blood amylase and urinary diastase tests and recommend that both be done simultaneously in questionable cases. (*Richard A. Leonardo, M.D.*)

MISTAKES IN THE DIAGNOSIS OF CANCER

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THE diagnosis of cancer as the disease manifests its protean characteristics in all body organs is subject to many pitfalls. Many diseases and pathologic conditions mimic cancer in all its stages. All hospitals and institutions devoted to the treatment of cancer have this problem ever before them, i.e., the patient who does not have cancer but an entirely different disease which mimics cancer sufficiently to cause diagnostic confusion and error.

We report herewith a series of twelve cases illustrating mistaken diagnosis in cancer. All of these patients were referred to a hospital service for cancer with the diagnosis of carcinoma, most of them for terminal and nursing care.

The series is presented to call attention to the fact that in all stages of the disease, the thought must be borne in mind that perhaps the patient may not have cancer, and that all events in the clinical course must be scrutinized and all pertinent facts established beyond doubt.

CASE REPORTS

CASE I. E. C., vesico vaginal fistula (traumatic) diagnosed as cancer of the bladder: The patient, age sixty, was admitted in July, 1943. A letter from a doctor stated that she had been operated upon in November, 1941, (two years before) for a prolapse of the uterus. A subtotal hysterectomy had been done and the pathologic report had revealed carcinoma of the uterus. Following the operation she developed a vesicovaginal fistula. An attempt had been made to repair this on June 20, 1942, and "biopsy at this time showed cancer of the bladder." Another operation for the closure had been done in September, 1942, with poor results.

Examination on admission revealed a chronically ill patient with evidence of recent weight loss. Local examination disclosed edema of the vulva and leukoplakia of both labia. There were extensive multiple ulcerations of the right labia extending to the crease of the groin. The vagina was smooth and the cervix was clean. There was a rather large 1 cm. puckered fistulous opening in the mid-anterior wall of the vagina which entered directly into the bladder.

Under careful local treatment, including soaks, sitz baths, etc., the ulcerations of the vagina and labia gradually improved. Repeated biopsies of the edge of the ulcer did not show cancer. After much consideration and review of the history it was thought that the bladder fistula might be traumatic in origin, especially since no evidence of carcinoma had been found. Accordingly, it was decided to attempt to close the fistula again.

This was done September 23, 1943. The anterior wall was widely exposed. The walls of the fistulous opening were refashioned and the bladder wall dissected back underneath the vaginal mucosa. The fistula was closed by a double layer of sutures. There was only moderate tension on the suture line.

Convalescence was uneventful. There was no further leakage. The fistula has remained closed and she has been well since. When last seen January, 1946, she was in excellent condition. There was no sign of a fistula or malignant disease.

CASE II. E. D., encrustation cystitis diagnosed as cancer of the bladder: The patient was admitted July 3, 1945, at the age of sixty-eight. About two months prior to admission the patient began to have pain and burning on urination and oliguria. This was followed by a moderate amount of bleeding on urination. Cystoscopy done before admission was reported to have shown an extensive carcinomatous mass on the left side of the bladder encroaching upon and partially obstructing the left ureter.

Admission examination showed a rather senile individual with some evident emaciation, complaining of severe dysuria. The cystoscopic examination was repeated and "an area of inflammation with edema the size of a quarter

was found extending from the trigone toward the dome on the left side. In one area an ulceration was observed. The lesion seemed more inflammatory than malignant in character but one could not rule out malignancy from its appearance." Following two weeks of bladder irrigations and general therapy, reexamination showed that the mucosa of the bladder had greatly improved. There was some inflammatory edema above the trigone and only a very small ulcerated area to the left. Ureteral orifices now were normal.

The bladder irrigations were continued for a few more weeks. The urine became clear and her pain on urination ceased. Final diagnosis was changed to subacute hemorrhagic ulcerative cystitis. Further follow-up of this case disclosed that the bladder symptoms did not reappear and there was no further dysuria. The patient still continued to complain of general malaise, was forgetful and easily upset emotionally. Evidently these were continuing senile changes. On January 15, 1946 she felt fine and no dysuria was present.

The differentiation between simple ulcerative cystitis and ulceration due to bladder carcinoma is a difficult decision that the urologist is frequently called upon to make. When a negative biopsy is obtained, the encrustations may have to be washed or dissolved out first before one can obtain a satisfactory view. This is not always possible. Clinical observation and treatment of the inflammation is the only way to make the differential diagnosis with reasonable certainty.

Case III. L. T., bladder calculus and cystitis diagnosed as cancer of the prostate: The patient, age seventy-three, was admitted on September 8, 1945. His complaint has been frequent, painful, scanty urination which started a long while ago, approximately six years as nearly as he remembered. In 1943 he had a transurethral prostatic resection followed by a bilateral orchidectomy for this trouble. The pathologic report was carcinoma of the prostate. He improved following this but remained weak and feeble. For one year prior to admission he had been in a convalescent hospital. In the last three months he had been treated for a urinary infection with sulfadiazine. The diagnosis made by the referring physician was carcinoma of the prostate, recurrent, with spinal metastasis.

Examination revealed an old, chronically ill man, depressed but cooperative, with some evidence of senility. Locally there was a small anal fistula. The prostate was very small and atrophic as felt per rectum. The testes were absent from the scrotum. X-ray of the pelvis was negative, but a large lamellated calculus was noted in the bladder area on the film. In the hospital he had no specific complaints and required no specific medication although his general condition was not good. About October 24th, five weeks after admission, he started to become mildly irrational, then at intervals talkative, noisy or drowsy. By November 5th his condition was poor and from there on he slowly sank, became comatose and died November 11, 1945. He never got into proper physical condition to warrant cystoscopy or bladder exploration.

Reviewing the history and clinical course of this senile old man, we doubted the diagnosis of carcinoma before death. First, urinary disturbances were present for six years or more, and while this is known in carcinoma of the prostate, it is unusual. The average duration from onset of symptoms to exitus is three and one-half years if uncontrolled. The patient was able to void without urinary obstructive evidences and the prostate was small and smooth per rectum. There were no bony metastases to the pelvis. The lamellated calculus and its large size indicated that the stone had been there for a long time. The symptoms and entire clinical course, we thought, could be satisfactorily explained on the assumption of a bladder calculus with accompanying traumatic cystitis from pressure and friction between it and the bladder mucosa.

Autopsy revealed an emaciated, flabby man. The bladder when opened contained foul-smelling urine. There was an oval calculus 2 by 2 by 4 cm. The mucosa of the bladder was discolored, hemorrhagic and edematous. The prostate was small, partially atrophic, and no gross carcinoma was seen on cut section. Both kidneys were small, about one-half normal size, with granular cortex surface ½ mm. in thickness and indistinct markings. The medulla was grossly normal. The pelvic lining was slightly thickened but smooth. The remainder of abdominal viscera were normal. Permission was limited to the abdominal cavity. The post-

mortem diagnoses were: calculus in bladder, hemorrhagic cystitis, chronic arterial nephrosclerosis and probable uremia.

CASE IV. C. K., granuloma of the rectum diagnosed as carcinoma of the rectum. The patient, age forty-four, colored, was admitted on February 9, 1944. A note from her referring physician said she had carcinoma of the rectum. Her illness began in 1935 with constipation and drainage of whitish material from the rectum. In 1938 she saw a doctor who told her she had a fistula-in-ano. She was operated on for the same with no improvement. In 1940 she saw another physician and was operated upon again. In 1941 she had diarrhea; in 1942 and 1943 the diarrhea continued. It appeared to improve temporarily but then relapsed. During the past two months she had as many as thirty brown, greenish or whitish movements. They were occasionally streaked with blood and were black and foul-smelling. For the past nine months there had been weakness. There was persistent gaseous distention of the abdomen and she vomited at intervals of about two or three days.

Examination revealed a large colored woman who was slightly anemic. The anus was spastic and tender on entrance of the index finger. The canal was funnel-shaped and the pararectal tissues were rigid. There was no definite cancer seen or felt. The lumen of the bowel for 2 inches above the anus was about the size of a pencil. In other words, there was a long stricture here. X-ray showed alteration of the mucosal markings of the rectum in front of the sacrum and irregular areas of filling. Repeated biopsy revealed smooth muscle infiltrated with leukocytes and small foci of fibrous tissue but no carcinoma. Diagnosis was granuloma of the rectum. The Frei test was done on March 10th and was slightly positive.

Comment. The strictures which develop (principally in colored females) after long-standing harboring of the virus of lymphogranuloma inguinale were originally considered luetic, then gonorrheal. They are more apt to be confused with these two venereal infections than with cancer. Nevertheless the hard firm granular stricture which the end result of this disease presents, may easily be confused with cancer.

Regarding the relationship of these granuloma inguinale rectal strictures to cancer, David and Loring[1] reported three cases in which carcinoma followed long-continued granuloma and cited two other cases from the literature. Barber and Murphy[2] reported that in their series (forty-three cases) 8.6 per cent had associated malignant disease. However, in the discussion of David and Loring's paper Curtis Rosser[3] stated that in over 200 observed cases he "had never detected a squamous cell cancer developing in one of the lesions." Likewise in Singleton's series of 181 cases[4] "not one had developed cancer." Thus this long-standing, chronically infected lesion may metamorphose into cancer as any similar lesion does occasionally. However, the incidence of this change varies among observers: by some, never; others, rarely; still others find that an appreciable incidence of cancer develops.

CASE V. E. B., diverticulitis sigmoid x-ray and o.r. diagnosis given as carcinoma: The patient, age seventy-one, was transferred from another hospital on October 28, 1945. There had been abdominal distress for two or three years, especially in the upper portion, similar to gallbladder dyspepsia. For the past three months there had been increasing pain in the lower abdomen and progressive constipation. There had been no rectal bleeding or melena. On October 1, 1945, she became ill with acute bowel obstruction. X-ray two days later showed "an irregular filling defect in the sigmoid colon with distention of the large bowel proximal to this obstruction. Diagnosis carcinoma of the sigmoid colon." She had been operated upon October 14, 1945, two weeks before admission to our service. "Attempt was made to deliver the transverse colon, but because of the distention this was considered dangerous. Wound closed. Small cecostomy was done through McBurney's incision." The patient was transferred to our service October 28th, fourteen days postoperatively, with a fever of 101.4°F. preceded by chills and a mild cough.

Examination on admission showed an acutely ill, senile, white female, with a temperature of

101.3°F. There were crepitant rales in the lower lung. Pelvic examination showed a narrow vagina and no cervix. Rectal examination showed a black stool; fullness was felt high up in the pelvis but no masses. Hemoglobin 80 per cent; red blood cells 4,980,000; white blood cells 8,450. Clinically she had hypostatic pneumonia. Penicillin, sulfadiazine and intravenous glucose were all given to no avail. She died November 27, 1945, three weeks after admission.

Postmortem abdominal examination revealed: cecostomy wound with subcutaneous sinus leading upward to a previous transverse right upper quadrant incision. "There was no free fluid in the abdomen. The main pathology was in the sigmoid. Here there was an inflammatory mass the size of a fist. It consisted of organized fibrous exudate, edematous angulated sigmoid colon adherent to itself and to the loops of the small bowel contiguous with it. Upon separation of these loops, a small perforation in the sigmoid was visualized, and a small amount of brown fecal matter oozed through the opening. The perforation had ulcerated the mucosa and produced a secondary stricture. The obstruction was due to edema about the ulcerated site, plus the inflammatory mass and the angulation of the sigmoid colon.

"The inflammatory process made recognition of the diverticulum which had perforated impossible, but one or two inches above this area there were two more diverticulae, one 5 mm., one 4 mm. in depth.

"Microscopic examination of the ulcerated area showed chronic inflammation with ulceration; loss of epithelium; fibrosis and infiltration of the adjacent bowel wall. No carcinoma was found in several sections."

Comment. Brown and Marcley[5] concluded that in one-third of the cases of diverticulitis symptoms were the result of inflammation while in two-thirds they were the result of inflammation plus obstruction. Sixty per cent give a history of constipation or constipation and diarrhea. The obstruction in diverticulitis occurs as a result of infection and edematous thickening of the gut wall and of the mesocolon and surrounding fat. "It is an extrinsic inflammatory reaction causing contraction of the external coats of the bowel, in contradistinction to that produced by ulcerating carcinoma in which the contraction begins within and progresses outward" . . . "A sudden acute obstruction may arise even though the infectious process had been present in varying degrees for some time. If the attack does not subside there ensues a tremendous thickening of the mesentery and all the coats of the bowel which does not return to normal."[6] This narrowing plus adhesions and angulation frequently lead to obstruction.

This is the type which is frequently confused with carcinoma but the mass is usually larger and more tender. By x-ray the irregular pattern of bowel distortion is classically longer but x-ray uncertainty is well known.

At operation the mass may be excised for carcinoma, the true nature being discovered first on pathologic examination. D. F. Jones of Boston,[7] Tom Jones of Cleveland,[8] W. W. Babcock[9] among others have commented upon this diagnostic confusion. The more frequent mistake is to consider diverticulitis to be carcinoma rather than the reverse. None of the recent authors believe that diverticulitis is a precursor of carcinoma in any sense but the two occasionally coexist.[10]

Case VI. J. K., hepatic cirrhosis mistaken for cancer of the colon: The patient, age fifty-one, was admitted on January 7, 1942. The transfer sheet from another hospital stated that x-ray had shown obstruction at the splenic flexure, ascites and large liver. Diagnosis was "suspicious colonic obstruction produced by a neoplasm and ascites from peritoneal implantation of metastasis."

His illness was of one and one-half years' duration, consisting chiefly of cramps in the lower abdomen, pains after meals, constipation and bright red blood in stools. Four months previously he noticed enlargement of the abdomen. During the past two months there had been weight loss and increasing weakness.

Admission examination revealed a chronically ill, white male with moderate dyspnea, cyanosis of the lips and edema of the lower extremities. There was marked enlargement of the abdomen with prominence of the super-

ficial veins, shifting dullness and fluid wave. The liver was not palpable at that time.

Laboratory data were as follows: hemoglobin 70 per cent; red blood cells 4,500,000; white blood cells 6,500; normal differential.

A barium enema on February 5th filled the entire colon. It was normal except for two small polyps in the ascending colon. Paracentesis on four occasions evacuated 10 to 14 L. of straw-colored fluid. There was very rapid reaccumulation of ascitic fluid following each paracentesis. A peritoneoscopy was done on March 7th. Liver biopsy revealed cirrhosis. Microscopically, there were hyperplastic liver cells separated into pseudolobules by small bands of fibrous tissue, which here and there at the periphery had infiltrating small round cells. He died five days later, probably of liver insufficiency and hypoprotienemia. No autopsy was allowed.

Cirrhosis is not uncommonly confused with abdominal carcinomatosis. Both exhibit abdominal distention, ascites, constipation, emaciation and prostration. The x-ray of the colon may be misleading.* If the patient has a history of having used large quantities of alcohol over a long period of time, if the x-ray findings are inconclusive in search for a primary cause and if the ascitic fluid on tapping is clear and recurs very rapidly, cirrhosis may be suspected and the clinical suspicion verified by peritoneoscopy and liver biopsy. It is very difficult, however, to make this diagnosis in certain cases.

Case VII. R. B., polyp of fundus uteri confused with carcinoma of fundus uteri: The patient, age fifty-six, was admitted June 20, 1945. She had had her menopause at the age of forty-two, fifteen years previously. She had been bleeding very intermittently for the past six years and for the past five months the bleeding had been more continued and slightly increased in amount. There was weakness and some loss of weight. There had been no pain. The general examination was negative except for some loss of weight. The uterus was relatively normal in size with a slight erosion anteriorly. Currettage brought forth normal endometrial mucosa in small amounts. No carcinoma was found. Gynecologic consultation found the uterus normal and it was suggested that 50 mg. of radium for seventy-two hours be used to stop the bleeding.

In view of the fact that a satisfactory explanation was not obtained for the post-menopausal bleeding, it was decided to do a laparotomy and a complete hysterectomy. This was done on June 25th. After removal of the specimen the endometrial cavity was opened. A small polyp was found at the top of the fundus. This was the apparent cause of the bleeding which had gone on intermittently for six years. Convalescence was perfectly satisfactory. Microscopic section of the uterine polyp revealed hyperplasia of the endometrium with the glands tortuous, hyperplastic and in papillary formation. No malignancy was demonstrated.

Only about 50 per cent of post-menopausal bleedings are due to cancer.[12–15] Of the benign lesions responsible for post-menopausal bleeding, cervical ulceration represents 10 per cent, post-menopausal vaginitis 7 per cent, cervical polyps 6 per cent, fibroids 4 per cent, endometrial polyps, endometritis, ovarian tumors, no pathologic change whatever, each represent a very small percentage.[12]

Case VIII. Foreign body (sponge in abdomen), diagnosis: pelvic carcinoma: C. G., age fifty-six, was admitted August 9, 1945, with a diagnosis of abdominal carcinoma. The patient had had a laparotomy for some pelvic complaint twenty-five years before; two and one-half years later she underwent an emergency laparotomy for bowel obstruction. After this she had been apparently well until the past five or six years. Five years ago a diagnosis of duodenal ulcer was made and the patient was put on a diet. Since that time she had occasional epigastric pain and eructations, with flatulence. This always responded to an ulcer regimen consisting of diet, alkalies, etc. Hospital history at another institution stated "has had known gastric and duodenal ulcer for the past five years."

* Saltzstein and Sandweiss[11] in 1921 reviewing twenty-two cases of cancer of the colon, all of whom died of the disease, found that 22 per cent of these cases had had x-ray examination which were indeterminate or negative. "A greater per cent of error was made in hepatic, transverse, and splenic flexure growths than in descending and ascending colon tumors."

She had been fairly well until May 21, 1945, when she was seized with a sudden attack of fainting and passed a large amount of dark blood per rectum. She felt nauseated, seemed to taste blood but never had emesis. Since then she had frequent tarry stools almost daily. After four or five weeks of this she had been hospitalized at another institution. There her blood pressure was 95/60. A moveable mass 3 by 4 inches was palpable low in the abdomen and slightly to the left of the umbilicus. She was in some shock which was remedied with blood transfusions. X-ray of the stomach revealed no evidence of disease. A barium enema filled the entire colon. "We found no evidence of disease in the intestinal tract. There is a possibility of an extra colonic mass in the lower left abdomen which may have to be determined clinically." She was discharged after a few days.

However, within a week she had another severe hemorrhage from the rectum and was re-admitted to the above hospital on July 16, 1945. X-ray of the stomach and duodenum was repeated and was again negative. No source of bleeding was found. The suggestion was to have an x-ray of her chest and a gastric analysis. One consultant had suggested a laparotomy for a suspicion of carcinoma. This was not done. She was transferred to our service August 9, 1945. Consultants diagnosis on transfer chart was "pelvic tumor with fixation to the bowel which causes the hemorrhage. May have to resect bowel."

Examination on admission to our service revealed a very pale and bled-out woman, otherwise alert and active. Her hemoglobin was 3.5 Gm. or 21 per cent, red blood cells 1,430,000. She improved under repeated transfusions and her blood count finally went to 41 per cent (7.3 Gm.) red blood cells 2,280,000. A mass could at times be felt in the left lower or mid-abdomen but at other times it was absent. Our barium enema stopped in the lower sigmoid. It was decided to explore the abdomen, the diagnosis being far advanced carcinoma of the sigmoid.

Exploration revealed a normal, thin sigmoid colon free and clear throughout its extent. In the lower reaches of the ileum there was a mass the size of a small orange. It consisted of three matted loops of small bowel, plastered against a cyst-like cheesy inspissated mass. One loop of small bowel was easily detached. A second loop was so involved that the serosa along one side had been destroyed. A third loop was intimately attached and there was an ulceration 1 cm. in diameter connecting the lumen of the small bowel with the mass. The mass was peeled away from the mesentery. It seemed to have a pseudocyst wall. It was not a dermoid but in the center was an old disintegrated laparotomy sponge. The bleeding had been caused by the ulceration into the small bowel. Th ulcer was trimmed and closed, the second loop where the serosa was destroyed was excised and re-anastomosed. The patient made an uneventful recovery. On January 12, 1946, her condition was excellent. She had no complaints and bowel movements were O.K.*

A sponge left in the abdomen at the conclusion of a laparotomy goes through a definite clinical course.[16] During the first month it is incidental to the inflammation and may suppurate and discharge either through the incision or through an abscess pointing into the rectum or vagina. After the acute inflammation has subsided the sponge is a foreign body and may extrude as such through a sinus, either externally or into the bowel, bladder or vagina. Later on the sponge is a well encapsulated foreign body (after two or three years).

The process of extrusion into the bowel happens in one-fourth to one-third of the cases and usually causes symptoms of indigestion and obstruction; that is, mild pain at irregular intervals, grading into violent colic with vomiting. In Crossen and Crossen's[16] review of 250 patients in whom a sponge had been left in the abdomen there was no report or mention of gross blood or serious bleeding into the bowel lumen.

On the other hand, a very small lesion in the jejunum or ileum may cause severe intestinal bleeding. Segal and Merle Scott[17] have recently called attention to this and mentioned one case in which a minute polyp in the ileum caused almost fatal hemorrhage. Large melena of obscure origin is well known and is a diagnostic problem which occasionally presents itself

* This case has been reported in detail elsewhere.

in all general surgical clinics.[18] A sponge ulcerating into the bowel lumen twenty years after being left is apparently a rarity, but the confusion of hidden or obscure small intestinal bleeding with carcinoma of the bowel is not too uncommon. The diagnostic error frequently results from the fact that a lesion in the small bowel is so rare that it is not thought of as a diagnostic entity; often, therefore, no x-ray of the small bowel is obtained.

Case IX. Jaundice due to common duct stone diagnosed carcinoma of pancreas: H. W., age 76, was admitted to our service on December 7, 1945. The patient was a senile old lady from whom no history could be obtained. Her daughter stated that she had been jaundiced for a short time prior to admission and that four doctors had told her that her mother had carcinoma of the pancreas. Physical examination on admission revealed a chronically ill, emaciated, senile white female with a moderate degree of icterus. There was a vague tender mass in the right upper quadrant. X-ray showed numerous gallstones in the gallbladder.

She was disoriented and confused and showed many evidences of central nervous system degenerative changes. Her jaundice slowly cleared almost completely and she ate well but usually dropped off into sleep after eating. After three weeks of this vegetative existence she became stuporous, lapsed into coma five days before death and quietly expired. Postmortem showed a dozen large stones in the gallbladder and one stone in the common duct; the pancreas was normal.

Comment. This is another instance of a senile old patient quickly put into the easy diagnostic hopper—far advanced cancer.

Case X. Eczematous dermatitis of perineum and intertrigo mistaken for carcinoma of vulva: R. M., admitted February 6, 1946, age seventy-two, had been an inmate of a home for the aged in a city 60 or 70 miles away. She had complained of redness, swelling, burning in the perineum of three weeks' duration, associated with purulent vaginal discharge. The institution physician quickly diagnosed cancer of the uterus and she was transferred to our service for treatment of that condition.

Examination showed a well nourished and well preserved old lady. Locally, the entire region of the perineum, vulva and medial aspect of both thighs was reddened, edematous and infiltrated with what grossly appeared to be an old inflammatory weeping lesion; there was no inguinal adenopathy. Laboratory data were: hemoglobin 13 Gm., red blood cells 4,100; white blood cells 11,000; urine negative; no sugar. The condition responded promptly to moist alkaline compresses, etc. In two weeks it had completely disappeared.

Case XI. Loops of small bowel adherent in pelvis following irradiation for carcinoma of the cervix; death due to partial obstruction and inanition: G. S., age fifty-four, was admitted to our service on June 16, 1944. Subtotal hysterectomy and salpingectomy had been performed in 1934 for pelvic abscess. A vaginal bloody purulent discharge had been noted since September, 1943. In March, 1944, a microscopic diagnosis of adenocarcinoma of the cervix grade 4 was made. The patient received radium on two occasions (March 18 and April 1, 1944, 100 mg. in each dose). This was followed by deep x-ray therapy.

On admission examination to our service (two and one-half months after the second radium application) the patient was a fairly well nourished middle aged woman appearing chronically ill. There was marked irradiation pigmentation over the abdomen. The vagina easily admitted two fingers. The mucosa was pale; the cervix was taken in in the vaginal vault. There was no fixation of the parametrium and no induration about the cervical stump.

Intravenous pyleogram showed normal calyces and no obstruction of the ureters. Hemoglobin was 62 per cent or 10.5 Gm.; red blood cells 4,040,000; white blood cells 11,000. Admission diagnosis was carcinoma of the cervxi and post-radiation sickness. (Previous radium and x-ray therapy three months ago.) She lay in bed under our care for three months. The nurses charting continued to note vomiting almost daily. At first the notes were "nauseated" and "slight emesis of greenish fluid." After about one month the notes began to state that the vomitus was brownish liquid. Every one, two or three days there was a note that the patient had had a bowel movement but still the nausea and emesis continued once or twice a day at least. In July she began to require more frequent narcotics. Her condition was

not good and at times she showed symptoms of drug addiction; she was noisy, cried out with pain which responded immediately to hypodermic injection. Her condition continued exactly as above with daily notation of emesis and relatively normal bowel movements without cathartics. About September 14th she began to be drowsy, required very few narcotics and slowly sank into coma and died on September 24th.

Autopsy revealed the following: uterus, tubes and ovaries not found, having been removed probably at the former operation. "There is an area of induration in the floor of the pelvis at the former site of the cervix. To this three loops of small intestine were adherent, as well as adherent to each other. The bowel at the site of each of these adherent regions presented a ring of bluish black, flattened, thin-walled mucosa. On separating these, perforation ensued. No gross carcinoma was seen here. There were no nodes felt or visible in the pelvis, but at the bifurcation of the right common iliac there was a firm node about 2 cm. in diameter, grossly appearing to be carcinoma. Microscopic examination of this node revealed metastatic carcinoma. There was also some atelectasis of the right lung."

Comment. In retrospect and review, this patient lay under our care for three months with a picture of partial small bowel obstruction, i.e., nausea and vomiting and pain in the abdomen but nevertheless had bowel movements. The diagnosis escaped us. We thought the continued vomiting and nausea due to (1) radiation sickness (2) drug addiction and (3) impending uremia seen so frequently in these cases. It is well known that because the contents of the small bowel are liquid, there can be considerable narrowing without the dramatic symptoms of obstruction; there is enough delay to cause nausea and vomiting and some abdominal discomfort and cramps but sufficient lumen to allow the passage of bowel movement.

The clinical syndrome of small bowel damage following irradiation therapy to cancer of the cervix is very well known and has been emphasized repeatedly in the past few years. It is especially liable to happen from irradiation of the cervical stump. The reasons are: The coils of the small bowel are very apt to be adherent in the pelvis from the previous hysterectomy, and the heavy shield which the uterine structures make between the peritoneal contents and the destructive effects of the radium is absent. In retrospect again, the indication would have been laparotomy and liberation of the adhesions of the small bowel.

At the time of death and at autopsy one gland at the bifurcation of the common iliac vessels on the right side was found to be carcinomatous. Taussig[19] found that in 23 per cent of borderline cervical carcinomas, malignancy persisted in the regional gland after heavy irradiation. In early and borderline cases he routinely dissected out the glands regional to the cervix, the inguinal nodes and those along the hypogastric and iliac vessels. Taussig could cure twenty-one per cent of those who had lymph node extension (a small series but all of these presumably would have died). Bonney obtained similar results with the radical Wertheim operation. (Quoted by Meigs.[20])

There is a trend in several clinics today to revive the radical Wertheim operation or some modification in certain cases, chiefly those considered good risks, with the disease limited to the cervix, or irradiation-resistant tumors.[20]

Case XII. Simple gastric ulcer causing exsanguinating bleeding: N. B., age eighty-two, was admitted to our service August 24, 1942. Admission diagnosis was probable carcinoma of the gastrointestinal tract. The patient was a senile old lady who was disorientated and confused so that history was difficult to obtain. She had had an operation, probably for an ovarian cyst, several years ago. She had lost fifteen pounds in weight the past nine months. There had been no emesis but she had had black stools for the past two or three weeks. There was also some constipation. Examination revealed an anemic, chronically ill, confused and disorientated old woman. She had bilateral parotitis. The abdomen was relatively normal. Hemoglobin was 25 per cent; red blood

cells 2,830,000; white blood cells 8,900; stools showed positive benzidine. X-ray examination was unsatisfactory because of the patient's condition. Fluoroscopy of the stomach did not show anything remarkable, but the barium enema showed a partial obstruction at the rectosigmoid junction. She gradually became weaker, did not vomit and slowly lapsed into coma and died quietly on September 18th, three weeks after admission.

Autopsy showed a shallow simple benign ulcer on the posterior wall of the stomach 2 cm. in diameter. The walls were smooth, sharp-edged and smooth-based.

Microscopic examination showed simple ulcer of the stomach with no atypical cell proliferation. Cecum and ascending colon were filled with reddish black contents which represented partially digested old blood. The barium enema appearance of the colon was explained by the autopsy finding of a long mesentery of the sigmoid colon tightly adherent to the parametria and uterus where the previous operative site had been. This was enough to produce angulation of the bowel which delayed the passage of barium per rectum.

Comment. Simple gastric ulcer in a patient this age is not common, but apparently in this instance it caused bleeding sufficient to exsanguinate the patient and she did not recover. As noted at the time of admission her hemoglobin was 25 per cent. There probably was continued seepage during the three weeks she was under our care. This is another instance in which a quick diagnosis of carcinoma was made in an elderly individual.

SUMMARY

Twelve cases are presented in which various non-cancerous lesions were confused with cancer: (1) Vesicovaginal fistula (traumatic) confused with cancer of the bladder; (2) encrustation cystitis confused with cancer of the bladder; (3) bladder calculus confused with cancer of the prostate (recurrent); (4) granuloma of the rectum confused with cancer of the rectum; (5) diverticulitis of the sigmoid confused with cancer of the sigmoid; (6) portal cirrhosis confused with cancer of the colon; (7) polyp of the fundus uteri confused with cancer of the endometrium; (8) foreign body (sponge) in abdomen confused with cancer of the bowel; (9) gallstones confused with cancer of the pancreas; (10) dermatitis of the vulva and perineum confused with cancer of the vulva; (11) intestinal obstruction from radiation damage to bowel confused with the terminal stage of cancer of the cervix; and (12) hemorrhage from simple gastric ulcer confused with gastrointestinal cancer.

CONCLUSIONS

In view of such experiences as the above, we have formulated certain rules to guide us in the diagnosis and treatment of this type of patient:

1. *Accept no diagnosis unless absolutely proven* either by biopsy or other satisfactory method. Cancer is one diagnosis which must be established one way or the other. It does not permit or allow guessing. An error may mean a patient's life. The evidence on which the diagnosis is based including the radiograph and the microscopic section, etc., must be critically examined; if indicated these should be repeated.

2. *A period of observation* may be necessary before a correct and final diagnosis can be established.

3. *Laboratory findings are only diagnostic aids.* If they do not fit in with the history and clinical findings, they should be reviewed, repeated or investigated further.

4. *If the clinical history does not coincide with the natural course of the disease,* question one or the other. A new and unsuspected approach may be discovered.

5. After all diagnostic procedures, observations, etc., are exhausted and there is still uncertainty, surgical exploration may have to be seriously considered if the patient's condition warrants.

6. *An apparent recurrence* in a patient who previously may have had cancer, *may be a new* and perhaps non-malignant *lesion.*

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GIANT FOLLICULAR LYMPHOBLASTOMA OF THE APPENDIX*

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THE purposes of this paper are to report a case exhibiting a lesion which is rarely found in the appendix, to correlate this case with similar ones already reported and to point out the probable identity of this lesion with one which is now recognized as the distinguishing feature of a definite disease entity.

CASE REPORT

A thirty-four year old negro housewife was hospitalized May 2, 1943, because of disturbances in the rhythm and volume of her menstruation and because of recurrent attacks of abdominal pain.

Her menstrual cycles were normal from their onset at the age of twelve until the last year before hospitalization except for an interval of nine months of amenorrhea ending in the delivery of a stillbirth in 1931. Thereafter she had an intermenstrual brownish vaginal discharge which took on an offensive odor as her menstruation changed. At first there was a gradual prolongation of each flow, increasing from four or five days to seven or eight. During the last two months before hospitalization she flowed twice each month, passed numerous clots and experienced pre- and co-menstrual pain.

Early in 1940 the patient had an attack of epigastric pain associated with a sensation of hunger and relieved by the intake of food. For one year there were recurrent similar attacks which were relieved at first by the intake of food and later by the use of milk of magnesia. Under the latter treatment the attacks disappeared in 1941 and did not return. On February 19, 1943, the patient experienced a sharp pain in the right lower quadrant which radiated to the umbilicus. During the attack, which lasted two days, the patient's appetite remained good. She noticed that the pain became intensified whenever she ate, that she became nauseated whenever her stomach was full and that vomiting caused relief from both the pain and the nausea. An electric treatment given by a private physician for what he termed an "infected ovary," aggravated her condition. Without additional treatment the symptoms disappeared and the patient felt well except for constipation. A second attack on March 13, 1943, was associated with diarrhea. For this and later similar attacks she attended a public clinic and was treated by another physician without lasting benefit. The last attack, experienced on May 1, 1943, and characterized by severe pain in the right lower quadrant, nausea and vomiting, caused her to be referred to the hospital, with a tentative diagnosis of recurrent appendicitis.

The patient denied upper respiratory infections or swelling of lymph nodes in relation to these attacks. There had been no deaths in her family from diseases of lymphoid tissue. The members of her immediate family were all living and in good health.

Physical examination revealed a moderately obese woman who appeared to be in good health. There was no swelling of superficial lymph nodes. Pertinent findings were: tenderness in the right lower quadrant and a mass felt in the lower abdomen; a relaxed but intact perineum; enlargement of the uterus upward and to the left attaining the size of about a four months' pregnancy; a slightly enlarged, freely movable cervix which was painless when manipulated; pain on movement of the uterus; tenderness in the parametrial regions but no masses were identified; a thick, purulent discharge from the cervical os and Nabothian cysts in the anterior lip of the cervix. Rectal examination failed to reveal additional changes.

Laboratory examinations of the urine and blood revealed the urine to be normal; serology (Hinton and Eagle) was negative; red blood cells, 5,670,000; white blood cells, 5,400; polymorphonuclear, 71 per cent; mononuclears, 29 per cent; sedimentation, 8 mm. in fifteen minutes, 16 mm. in thirty minutes and 18 mm.

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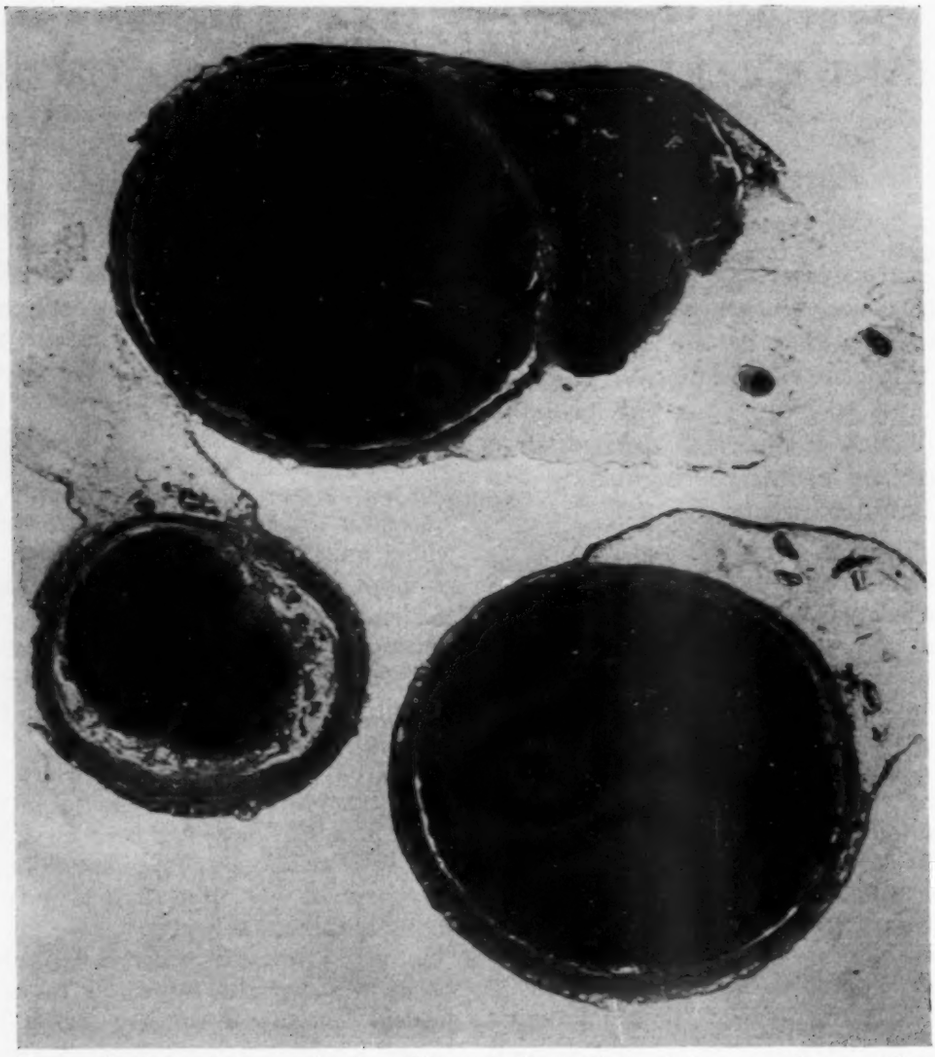

FIG. 1. Sections of the proximal, middle and distal thirds of the appendix, revealing hyperplasia of lymphoid tissue. The lumen is obliterated; the mucosa has disappeared entirely; in the section from the middle third the lymphoid tissue has spilled into the meso-appendix without destroying the muscle coats and a thin layer of submucosa; the process consists of a numerical and spatial hyperplasia of the lymph follicles.

in sixty minutes (Wintrobe method not corrected).

The patient was operated upon on May 7, 1943, under general anesthesia with the clinical diagnoses: fibromyomas uteri, bilateral salpingitis and recurrent appendicitis. Her condition during the operation was good. The findings at operation were: adhesions binding the omentum to the pelvic peritoneum, a cyst of the left ovary, distention of the left tube, enlargement of the uterus by subserous and intramural fibromyomas and enlargement of the middle and distal thirds of the appendix.

The adhesions were separated by blunt and sharp dissection. The uterus was removed supravaginally together with the left tube. The ovarian cyst was enucleated and the appendix was removed.

Postoperatively the patient ran a low grade temperature for five days and thereafter recovery was uneventful. She was discharged on May 17, 1943. When last seen on May 25, 1946, the patient appeared well and had no complaints. There were no enlargements of superficial lymph nodes.

The gross and microscopic findings in the pelvic organs were summarized by the pathologist as follows: subserous and interstitial fibromyomas of the uterus, healed left salpingitis with residual hydrosalpinx, serous cyst with compression atrophy of the left ovary and corpus hemorrhagicum of the right ovary

associated with endometrium in the late corpus luteum phase of the menstrual cycle.

The appendix was found to be 8 cm. long with smooth serosa, injected serosal vessels and moderately abundant adipose tissue in its mesentery. It had a diameter of 8 mm. in its proximal third and from 10 to 11 mm. in the middle and distal thirds. It was not readily compressible and when sectioned its lumen was found to be obliterated by a whitish growth. Microscopically, the lumen was obliterated, the mucosal epithelium was missing and its submucosa and muscle coats were compressed by an impressive growth of lymphoid tissue consisting of a numerical and spatial hyperplasia of its follicles and germinal centers. In one of the three sections studied the hyperplastic lymphoid tissue was found to have spilled over into the meso-appendix, sparing almost entirely the intervening and compressed muscle and submucosal coats. (Figs. 1 and 2.) The impressions of the pathologist were: tumor of lymph follicles (lymphoid folliculoma) of the appendix with obliteration of the lumen and invasion of the meso-appendix. A review of the available opinions on diseases of lymphoid tissue led to a final diagnosis of giant follicular lymphoblastoma.

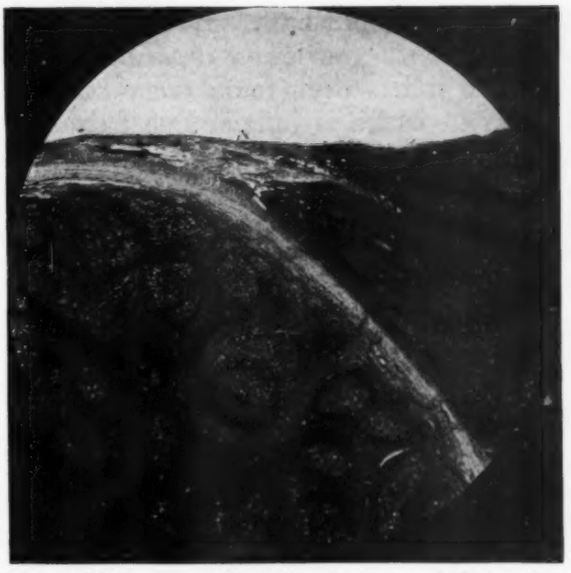

FIG. 2. Higher magnification of a part of the section made from the middle third of the appendix.

COMMENT

In the references available to us when the case was first studied there were reports of only six patients exhibiting lesions of the appendix of the type herein reported.[3,9,11,12,17] The pertinent data on these cases, on three others reported recently[10] and on our own are presented in Table 1. In addition to these allusions have been made to at least four other cases which appear to be of the same type. Lehman[9] refers to two, the case of Müller and another described by Pigot, and the other two are cases IV and V of Gruenwald[6] who reported recently on five instances of abnormal follicles in the digestive tract. We have been unable to find the original descriptions of the cases to which Lehman referred. His brief reference to them does not include their symptoms or a full description of their appendiceal lesions. Similarly, Gruenwald does not include clinical pictures of his cases. Moreover, his reports on cases IV and V do not include photomicrographs of their appendiceal growths and his description of the lesion in case V is not very clear.

It is apparent from the table that these cases exhibit a wide range in age incidence and that they are equally divided as to sex. It is apparent also that the lesions may be nodular, pedunculated or diffuse and that they may merely fill the lumen of the appendix or obliterate it either locally or in its entirety. As a group these cases deserve special study because these lesions may mimic appendicitis or appendicitis may be exhibited as a complication. They present a very special problem in diagnosis.

It is probably true that in the field of diagnosis there is no sector which is hedged in with more difficulties than that borderland between inflammatory hyperplasias and neoplasms. This is particularly true where lymphoid tissues are concerned[4] and is well exemplified by the cases under consideration.

Wilhelm and Delval,[17] the first to describe this entity, considered it to be an inflammatory tumor of the appendix. Because the appendix is so frequently the seat of inflammation, one is tempted at first to agree with them. However, a second thought must cause one to doubt that in-

flammation could have any etiologic relationship with the lesion described herein because it has been found very rarely in an organ which is inflamed so frequently and is so accessible surgically that it has been submitted to gross and microscopic study about as frequently, if not more frequently, than any other internal organ.

Since the report by Wilhelm and Delval and before that by Morehead and Woodruff,[10] the condition had been labeled polyposis due to hyperplasia of lymphoid tissue, lymphoid hyperplasia, lymphoma, benign lymphoblastoma and abnormal accumulations of lymph follicles. It seemed to us, however, that a more accurate opinion about the nature of the lesion which these cases exhibit might be obtained if reference were made to similar alterations found in other lymphoid tissues of the body. Such an opinion led to our final diagnosis in the case reported herein and it is embodied in the paper by Morehead and Woodruff who interpreted the growths found in their three patients as examples of solitary giant follicular lymphoma of the vermiform appendix. In alluding to the cases reported by Stout,[12] Wilhelm and Delval and Lehmann and Gruenwald, however, Morehead and Woodruff recorded the impression, "In each instance the microscopic picture was that of simple lymphoid hyperplasia."

Brill, Baehr and Rosenthal[2] reported in 1925 a "hitherto undescribed condition" which they characterized as a generalized lymph follicle hyperplasia of lymph nodes and spleen. Symmers[13] reported on the same condition two years later. Since then the name Brill-Symmers disease has been applied to it and a fairly complete picture of the disease has evolved from new reports and follow-up studies of the older cases. It is now admitted that (1) although the interest of the medical profession in this condition was aroused by the reports of Brill, Baehr and Rosenthal and Symmers, there had been earlier descriptions of its characteristic lesions, probably the earliest being that of Becker[1] in 1901; and (2) whereas originally the disease was considered to be benign, later evaluation revealed cases which became undeniably malignant.[14,15]

The characteristics of Brill-Symmers disease as originally conceived and as

TABLE 1

Case No.	Authors	Year	Age	Sex	Clinical Data									Pathologic Data		
					Pain in Right Lower Quadrant	Nausea	Vomiting	Tenderness in Right Lower Quadrant	Rigidity or Resistance	Temperature	Diarrhea	Constipation	Urinary Frequency or Urgency	Inflammation	Adhesions	Tumors
I	Wilhelm and Delval	1910	17	M	+	..	+	+	..	+	..	..	..	−	*	Pedunculated growth at tip
II	Lehmann	1925	20	F	+	+	..	..	..	..	+	..	..	−	..	Nodule in distal third
III	Stout	1927	8½	F	+	..	+	+	..	+	..	+	+	+	..	Nodular enlargement at base; acute inflammation distally
IV	Stout	1927	9	F	+	+	..	+	..	+	..	..	+	−	..	Distal half obliterated by growth
V	Evans	1931	55	M	+	..	+	+	..	..	..	+	..	−	..	Nodule at base causing swelling
VI	Ruggieri	1938	39	M	+	+	+	..	..	..	..	..	..	−	+	Proximal third obliterated and enlarged by growth; distal two-thirds obliterated by fibrosis
VII	Morehead and Woodruff	1945	33	F	+	+	+	+	+	..	..	..	..	−	−	Distal third obliterated and enlarged by growth
VIII	Morehead and Woodruff	1945	12	M	+	+	−	+	−	..	..	..	..	+	+	Distal third obliterated and enlarged by growth; diffuse infiltration by eosinophils proximally
IX	Morehead and Woodruff	1945	26	M	+	..	..	+	+	..	..	..	..	−	+	Distal third obliterated and enlarged by growth
X	Jason and Malloy	?	34	F	+	+	+	..	..	..	+	+	..	−	−	Distal two-thirds enlarged; entire lumen obliterated by growth

* Case I, Appendix retrocecal

modified by later studies are described in sufficient detail elsewhere.[1,7] It is well to point out that the disease is of insidious onset, consisting of a localized or multicentric enlargement of lymphoid tissues due to a numerical and spatial hyperplasia of their follicles and germinal centers. It may occur at any age (reported range from two to seventy-seven years). It runs a benign course for a very long time and may either remain so and heal or may become malignant in character. During its benign course the lesion is highly radiosensitive; the patient appears in good health, does not exhibit either anemia or cachexia nor does he have abnormal cell forms in the blood. There is a tendency toward involvement of the lacrimal glands and occasionally the lympho-epithelial structures of the digestive system are affected.

Having in mind these and other characteristics of Brill-Symmers disease,[7,8] it becomes readily apparent that the several cases under consideration correspond perfectly to the early stages of that form of the disease in which there are only localized lesions. There are no positive findings in either one of the two groups of cases which can justify their separation as distinct clinical or pathologic entities. Their lesions are identical and the cases reported herein are distinguished solely by the fact that their lesions occurred in the appendix and thereby modified the clinical course.

While attempting to justify the inclusion of these cases within the scope of Brill-Symmers disease, it must be borne in mind that there are no adequate follow-up studies on any of them. Even the case reported herein has been followed for only three years which is more than half the average duration of the cases of Brill-Symmers disease which have terminated fatally (4.8 years). This, however, is not considered to be sufficient basis for their exclusion not only because of the impressive similarity, if not identity, of their microscopic lesions, but also for the reasons which follow.

Symmers[15] recorded his impressions to the effect that the disease named in part after him, at least in its early stages, naturally is inclined in the direction of benignancy and that spontaneous diminution in size of the nodes or apparently complete disappearance may occur. He added that this may happen even late in the course of the disease. In this connection it is to be remembered that patients may tolerate enlargements of superficial lymph nodes for a long time without seeking medical treatment, particularly so if these are not associated with pain or other disturbances of their well being. It is to be remembered, too, that the appendix in the presence of hyperplasia of its lymphoid tissues is not likely to remain symptomless quite as readily as superficial lymph nodes.[15,16] It is highly probable, therefore, that cases of Brill-Symmers disease which have their initial lesions in the appendix will become evident clinically at an early stage in their development and, therefore, may be cured by the surgical removal of this organ. Moreover, since appendectomies are such relatively common operations, the finding of an appendectomy scar in a patient exhibiting the lesions of Brill-Symmers disease in their usual localizations is not likely to excite suspicion of an earlier manifestation of the disease in this organ so that an attempt at correlation is not likely to be made.

SUMMARY

1. A case report is made of a patient whose appendix had its lumen obliterated by a giant follicular hyperplasia of its lymphoid tissue.

2. Correlation with nine reported cases reveals the features these exhibit in common as well as their variations.

3. An attempt to identify the condition exhibited by these patients leads, on morphologic grounds, to its inclusion within the term giant follicular lymphoblastoma (Brill-Symmers disease) as suggested by Morehead and Woodruff for their three cases.

4. The belief is expressed that these cases, revealed early in the evolution of the disease because of the occurrence of the lesion in the appendix, may have been cured by appendectomy while the disease was still localized.

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INTESTINAL OBSTRUCTION DUE TO MESENTERIC HIATUS*

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ACUTE intestinal obstruction can be caused by the incarceration of a loop of bowel through an aperture in the mesentery. Although such a defect is uncommon, it should be considered in evaluating the possible causes of a bowel obstruction when the etiology is obscure. The condition has never been diagnosed before operation. The following case history is submitted as an addition to those already cited in the literature.

CASE REPORT

Mrs. M. L., No. 8804, eighty-eight years old, a resident of the City Home, was admitted to the Second Surgical Division of Goldwater Memorial Hospital on May 10, 1946, complaining of abdominal pain and vomiting for six hours. She had not moved her bowels for twenty-four hours but she had been able to expel flatus. There had been some weight loss during the preceding six months but her appetite continued good until the onset of her illness. There had been no melena. During a previous stay at the hospital from May 2, 1944, to January 3, 1945, she was treated for generalized arteriosclerosis, hypertension, chronic myocarditis and diffuse osteoarthritis of the spine.

Upon examination she did not appear acutely ill or in pain. Her temperature was 98.6°F., her pulse was 80 and her respirations 18. The heart was somewhat enlarged, the rate was regular and there were no murmurs. The blood pressure was 170/100. The lungs were clear. Her abdomen was slightly distended in the lower half but soft throughout. There was no visible peristalsis. There was mild diffuse tenderness and this was most marked in the right lower quadrant. An abdominal mass could not be palpated. Digital examination failed to show stool in the rectum. The blood count showed red blood cells 4,000,000 and white blood cells 12,000 with 80 per cent polymorphonuclear cells and 20 per cent lymphocytes. The hemoglobin was 75 per cent (Sahli). On May 11th roentgen ray examination of the abdomen demonstrated moderate dilatation of several coils of small intestine but a repeat study on May 13th showed an increase in the amount of gaseous distention and the appearance of fluid levels.

During the first twenty-four hours of her stay at the hospital the patient refused all treatment. She vomited small amounts of brown, odorless fluid. She continued to pass flatus but stool could not be obtained by enema. On the day of admission the tentative diagnosis was incomplete intestinal obstruction due to a tumor in the colon at the hepatic flexure. Conservative treatment was instituted in order to allow more accurate diagnosis and definitive treatment. However, stomach tube suction and rectal irrigation did not diminish her abdominal distention; and since roentgen ray study showed an increase in the number of distended loops of small intestine, it was decided that her obstruction had become complete and surgical therapy was mandatory.

Operation was performed on May 13, 1946, under combined local infiltration with 1 per cent procaine and cyclopropane inhalation anesthesia. The abdomen was entered through a gridiron incision in the right lower quadrant. The wound was enlarged toward the midline by incision of the sheath of the rectus abdominis. The peritoneal cavity contained a small amount of clear straw-colored fluid. The cecum and ascending colon contained a small amount of gas. About 20 cm. from the ileocecal junction there was an oval opening in the root of the mesentery of the ileum about 6 cm. in diameter. Its edge was smooth and rounded. A loop of ileum, 30 cm. long, had slipped through this hiatus and had rotated itself clockwise for about 170 degrees. The involved loop was distended but not discolored and the intestine proximal to the site of obstruction was moderately dilated. Immediately after reduction of the volvulus gas passed into the terminal ileum and cecum. The efferent arm of the

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incarcerated loop was adherent to the border of the mesenteric defect but was easily separated from it and then extracted from the opening. The patient's general condition was poor so that the operation was terminated without closing the mesenteric hiatus. The abdomen was closed in layers without drainage.

Supportive therapy was continued during and after the procedure but her condition became rapidly worse and she died eight hours after operation in apparent shock and cardiovascular collapse. Permission for autopsy was not obtained.

COMMENT

This case of incarceration of a loop of small intestine into a mesenteric hiatus is especially interesting in that it occurred in a patient at the age of eighty-eight. Since there had been no preceding operation or trauma, it is reasonable to postulate that the defect was congenital. Iagnov and Timus in an extensive discussion of this condition state that the available evidence indicates the congenital nature of mesenteric hiatus.[2] During the development of the fetus, portions of the mesentery are absorbed as the intestines rotate to assume their normal positions.[4] Defects may appear during this process.

The most frequent site for a mesenteric defect is near the ileocecal junction.[2] Such a location is illustrated by the case reported herein. Most of the cases in the literature showed strangulation of the involved intestine but this did not occur in our patient.

No evidence could be found in the literature of an accurate anatomic preoperative diagnosis of mesenteric hiatus. A review of our case and others[1,2,3] shows that the sudden onset of intestinal obstruction was the first indication of intra-abdominal disturbance. An exception to this was found in one patient who gave a nine-year history of occasional nausea and cramps after meals.[2] The possibility of a mesenteric defect in a patient who suddenly develops an obstruction of the small intestine without apparent cause must be kept in mind. Unfortunately there are no specific findings indicative of obstruction caused by such defects.

The treatment of mesenteric hiatus is essentially the treatment of the complicating intestinal obstruction. When possible, the defect should be closed.

A discussion of the cause of death of our patient is not appropriate to this report but lies within the scope of the larger problem of intestinal obstruction. It should be noted, however, that of the four cases reported by Watson,[1] Iagnov and Timus[2] and Baty[3] only one patient survived.

SUMMARY

1. A case of obstruction of the ileum due to its incarceration in a mesenteric hiatus is presented.

2. Mesenteric defects, without preceding trauma, are rare and probably congenital.

3. They should be suspected in cases of acute intestinal obstruction without a preceding history of intestinal disease.

4. The treatment of mesenteric hiatus is the treatment of the intestinal obstruction and the closure of the defect.

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HEMATOMA OF THE SCROTUM

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THIS case is reported because of its unusual character. A healthy young soldier with no evidence of local disease or direct trauma to the scrotum developed a hematoma of the scrotum after lifting.

CASE REPORT

R. H., age nineteen, white, was admitted to the hospital at 9:15 P.M. by ambulance on July 28, 1947. Two hours before admission he had lifted his foot locker and felt a sharp agonizing pain in the left groin; he fell to the floor. His barracks mates lifted him and put him on the bed where he lay for some time. He noticed a swelling forming in his left scrotum and an ambulance was sent for.

Two weeks previously in the course of doing similar duties requiring heavy lifting, the patient had felt a sharp pain in his left groin. At this time he had stopped lifting, rested and the pain had disappeared.

Examination at 9:45 P.M. showed a globular mass in the left scrotum, doughy in consistency and tender to examination. It did not transilluminate. The left external inguinal ring was tender; the right scrotum was normal.

There had been no previous history of varicocele or hernia and no history suggestive of blood dyscrasia in the family.

Physical examination showed a large, well developed, well nourished, blonde, young adult. The skin was flushed and the skin about the trunk and legs showed scattered papules (miliaria). Head, neck, throat, nose and eyes were all normal. Examination showed the heart and lungs to be normal; the abdomen was flat and there were no masses, tenderness or rigidity; sounds of peristalsis were normal.

The patient was taken to the operating room and under spinal anesthesia it was noted that the testicle could be outlined from the mass. A low parainguinal incision was made. A small hematoma within the spermatic cord about 1 inch below the external inguinal ring was noted and removed. There was much oozing of the structures about the inguinal canal. Structures of the spermatic cord were dissected and there was no evidence of a hernial sac. The veins of the pampiniform plexus seemed normal. The left testicle was lifted out of the scrotum and a large hematoma 3½ inches in diameter was seen attached to it infiltrating the median raphe. The hematoma was dissected away *en masse* removing strands of fatty tissue intimately connected with it.

The tunica vaginalis was opened and found to be perfectly normal and small in size. It was inverted and sutured. The scrotum was irrigated and the testicle reintroduced into it. Thrombin-soaked pieces of fibrin foam were placed around the testicle in the scrotal cavity and in the region of the inguinal canal in order to prevent a recurrence of hematoma from generalized oozing. Transversalis fascia was sewed to the shelving edge of Poupart's ligament as was the conjoined tendon. The external oblique aponeurosis was sewed over the cord reconstructing the inguinal canal.

Laboratory study showed the urine to be negative, white blood cells 9,400, hemoglobin 95 per cent. The differential count was 64 per cent polymorphonuclear cells, 31 per cent lymphocytes and 5 per cent mononuclear cells. Clotting time was two minutes, bleeding time one minute twenty seconds. Prothrombin time was thirteen seconds as against the control of fourteen seconds. Rumpel-Leeds test was found to be negative.

The postoperative course was uneventful. Early ambulation was not applied in this case. A pressure dressing was placed around the scrotum after operation and retained for three days. Sutures were removed on the seventh postoperative day. The scrotum remained normal in size throughout the postoperative period. A small amount of edema was noted about a week following operation on the left posteromedial side of the scrotum. A pyramidal mass above the left testicle was noted during the second week due to induration of the inverted tunica vaginalis. Examination on August 15th showed the testicle entirely normal.

COMMENT

This case is exceptional in that a large hematoma formed in the scrotum without any evidence of direct trauma; the incident that led to the condition was the lifting of a heavy locker. A possible rupture of a varicocele by this exertion is to be considered but there is no evidence of varicocele by previous history or examination, nor by the examination at the time of operation. The fact that the bulk of the hematoma was entirely outside the spermatic cord also makes varicocele improbable.

Another possible mechanism of injury by the sudden lifting could be a result of muscle pull. Cremasteric fibers attached to the external surface of the spermatic fascia could pull suddenly in consonance with the internal oblique muscle and a tear of the attached loop of fibers might occur. Such a pull can be so sharp as to conflict with the inertia of a low dependent testicle. It may meet such resistance of the scrotal ligament as to cause a tear of the vascular and nerve plexus which is said to be present there. In hot weather the surface temperature of the body will be increased, the muscle tone of the dartos muscle will be lessened and make the scrotum markedly dependent. The fact that fractures of bone are known to occur as a result of direct muscle action makes it reasonable to postulate such a mechanism here.

Surraco[1] points out that the scrotal ligament forms a plexus of arteries, veins, lymphatics and nerves and it is an area of lesser resistance in the scrotum. It is very likely to be the source of hematoma formation with any direct injury to the scrotum or testicle. He advises block excision of the hematoma as if it were a tumor.

In this case the pain was so acute and agonizing that the patient fell to the floor indicating that an area of generous nerve supply had been affected. The history showed that a similar milder incident which had not been followed by the tumefaction of hematoma occurred two weeks previously. This suggests that the patient was affected by some variation in anatomy of the inguinoscrotal region that could cause his cremaster to act more sharply than is usual.

The spermatic fascia[2] which is a continuation of the transversalis (or endoabdominal) fascia and the loop of cremaster muscle fibers (continuous with the internal oblique muscle) adhere to the external surface of the parietal layer of the tunica vaginalis. Surraco believes that the potential space between the spermatic fascia and the cremaster fibers is the locus for the formation of hematoma. But tear of the cremaster fibers would break such a limiting boundary and extend the effusion into the scrotal space of dartos connective tissue.

CONCLUSION

An unusual case of hematoma of the scrotum following lifting is reported. A probable mechanism of pathogenesis is described.

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New Instruments

THE FALLACY OF THE SO-CALLED THYROID CAPSULE*

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A SURGEON needs only to perform his first few thyroidectomies to realize the fallacy of the concept that a well defined capsule completely encircles the thyroid gland. The idea that the gland can be readily enucleated as soon as this capsule or sheath is entered is morphologically and surgically incorrect. It is true, however, that specific cleavage planes do exist which can be utilized surgically if one understands the fasciae surrounding the thyroid which form a sheath of areolar tissue with definite attachments to the gland.

Many accounts of the arrangements of the fascia of the neck have been presented and studied; those in the standard textbooks of anatomy are too well known to bear repetition. However, most of these descriptions tend to complicate rather than clarify the picture. The observations presented herein represent the result of research and observations over a ten-year period taken from dissecting, postmortem and operating rooms. It is on the living patient that the surgeon may verify the description submitted herein.

Certain general principles governing the arrangement of fasciae must be kept in mind. If these facts are appreciated, the cleavage planes which exist will not be looked upon as artifacts. Among such principles one must recall that most skeletal muscles are surrounded by fascia (exceptions to this are those which lie upon bone, cartilage, etc.). The strength of fascial envelopes varies tremendously; some appear as strong closed investments which form a sheath while others appear as only a thin enveloping layer. When two muscles overlie one another, the fascial layer separating them is common to both. Meyers and Macpherson[1] are of the opinion that this last mentioned fact is of paramount importance and has been lost sight of. We wish to emphasize this point since we are of the opinion that the fascia associated with the deep surface of the sternothyroid muscle is so closely related to the anterior lamella of the pretracheal fascia that they are at times fused and, therefore, are incised as a single structure. The fascia must be regarded as a specific living structure which can respond to stimuli in its own way. If this fact is kept in mind, fascia becomes a definite structure to be identified in the course of a well planned thyroidectomy. This discussion shall be kept only within the bounds of those regions which pertain to thyroid surgery.

Deep Cervical Fascia. The deep cervical fascia (fascia colli) consists of three layers (Fig. 1B), (1) a superficial or general investing layer; (2) a middle or pretracheal layer; and (3) a deep or prevertebral layer. These layers may fuse in the midline. The degree of fusion is dependent upon the amount of divergence of the infrahyoid muscles and on the number and arrangement of the anterior jugular veins which are situated between the fasciae of the sternomastoid and the sternohyoid muscles.

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General Investing Layer. The general investing layer is characterized by its ability to split and envelope muscles, namely, the trapezius and sternomastoid. Posteriorly, it is attached to the ligamentum nuchae and splits immediately to enclose the trapezius at the anterior border of which it reunites, thus forming the fascial roof of the posterior triangle of the neck. Reaching the posterior border of the sternomastoid, the fascia again splits to form an envelope for this muscle. The two layers again join, continue forward as the roof of the anterior triangle and become continuous with a similar layer on the opposite side. The general investing layer attaches above to the external occipital protuberance, superior nuchal line, base of the mastoid process, zygomatic arch and lower border of the mandible. It is attached below to the manubrium sterni, clavicle, spine of the scapula and the acromion process. In this way the superficial layer of the deep cervical fascia forms a circular tube which holds the structures of the neck in place. Everyone seems to be agreed upon the existence and arrangement of this layer.

Pretracheal Layer. The middle or pretracheal layer of deep cervical fascia is the one of greatest surgical importance. The sternohyoid and omohyoid muscles are situated in the same plane but the sternothyroid muscle is situated in the plane immediately subjacent to these. In this instance the pretracheal fascia supplies investments for the sternohyoid and omohyoid muscles, forms a loose areolar tissue cleavage plane beneath these and finally supplies a fascial envelope for the deeper lying sternothyroid. This areolar tissue which is found on the deep surface of the sternothyroid muscle is intimately related to the anterior lamella of pretracheal fascia which forms the anterior part of the sheath of the thyroid gland. It is because of this arrangement that the proper cleavage planes can be utilized in mobilizing the thyroid gland rather than following the fallacious thought that a separate thyroid capsule completely encircles the gland. Therefore, we note that when one identifies the sternothyroid muscle as a separate structure and dissects posterior to it, he automatically breaks through this sheath and exposes the thyroid gland. Although the surgeon has entered the proper cleavage plane and has incised the sheath, he cannot mobilize the thyroid lobe completely because of the lateral attachments of the pretracheal fascia. These attachments can best be described if one considers the pretracheal layer of deep cervical fascia in the following way: the pretracheal layer is considered an offshoot of the general investing layer.[2] It then passes horizontally in front of the carotid system. As it continues medially the fascia splits into two layers, a prethyroid layer (lamina) and a pretracheal layer (lamina) proper.[3] (Fig. 2B.)

The prethyroid layer of pretracheal fascia is a thin anterior lamina which extends medially. It is loosely attached to the gland along an irregular line which is located at the junction of the middle and posterior thirds of the superficial surface of the lateral lobe. At the upper pole it extends medially, anterior to the superior thyroid vessels and, toward the midline, firmly blends with the pretracheal layer proper of pretracheal fascia. At the lateral margin of the pyramidal lobe it again divides from the pretracheal fascia, extends over the anterior surface of the pyramidal lobe and blends with the prethyroid fascia from the opposite side. Inferiorly, the prethyroid fascia is attached to the gland along a line which extends around the lower pole and across the inferior margin of the isthmus. In this region it supplies an anterior covering for the inferior thyroid veins. Lateral to the thyroid gland this lamina is separated from the pretracheal lamina proper by a triangular space which is filled with loose connective tissue and which Sloan[3] has referred to as the postthyroid space. The sides of this anatomic triangular space are formed by the prethyroid fascia anteriorly, the pretracheal fascia proper posteriorly and the thyroid gland medially. (Fig. 1B.) It extends along

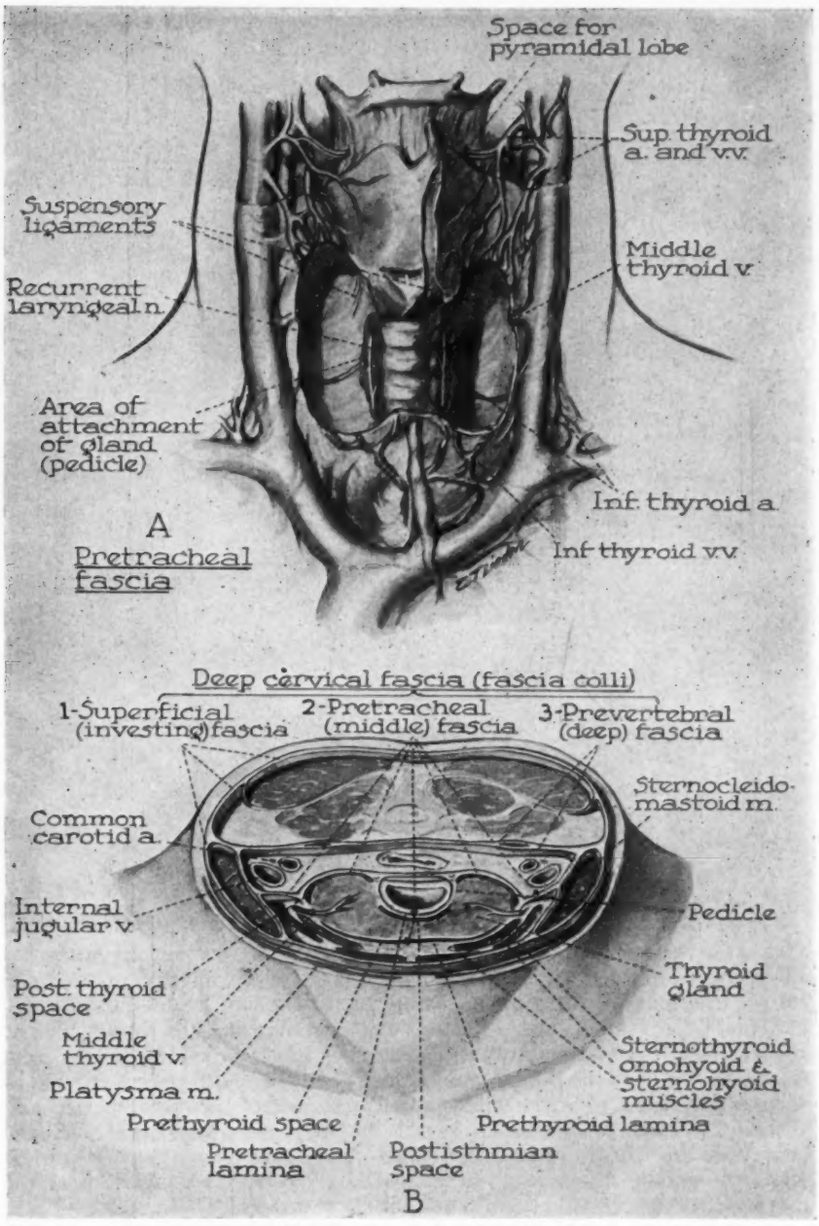

FIG. 1. A, the suspensory ligaments of the thyroid gland are shown passing from the inner margins of the gland to the cartilaginous framework. The vessels and recurrent laryngeal nerve as related to the pretracheal fascia are demonstrated. B, the deep cervical fascia (fascia colli) in cross section. This fascia consists of three layers: superficial (investing), middle (pretracheal) and deep (prevertebral). The important pre- and post-thyroid spaces are shown as related to the middle thyroid vein.

the postero-lateral border of each lateral lobe from the superior thyroid vessels to the lower pole.

The pretracheal lamina proper of pretracheal fascia extends medially passing behind the thyroid lobe, the lateral border of the esophagus and the trachea. At this point it thickens to form the pedicle of the thyroid gland. These anterior and posterior laminae do form a sheath but the fixations of the sheath to the gland must be understood if proper mobilization is to be effected. The fixation of the gland in the region of the pedicle is firm, hence, no cleavage plane exists. From this pedicle the fascia extends medially over the tra-

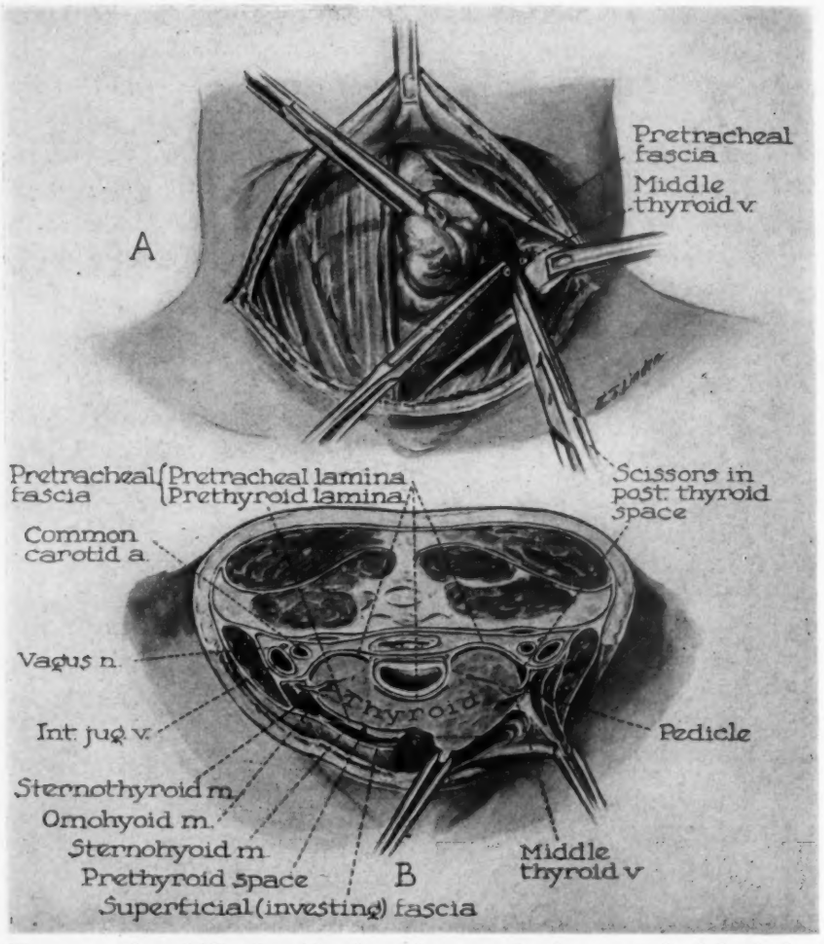

FIG. 2. A, the middle thyroid vein as it passes in the pretracheal fascia has been severed and ligated. By so doing the post-thyroid space is entered and the thyroid lobe can be properly mobilized. B, the two laminae (prethryoid and pretracheal) of pretracheal fascia are diagrammatically shown. To the reader's right the prethyroid space has been entered; the middle thyroid vein separates this from the post-thyroid space. The prethyroid space is entered as soon as the fascia which lines the posterior surface of the sternothyroid and the areolar tissue which forms a sheath for the thyroid gland is incised; the latter two are usually intimately related. The post-thyroid space is entered when the middle thyroid vein is severed and the lateral attachment of the pretracheal fascia to the lateral border of the thyroid lobe is incised.

chea and larynx to become continuous with the same layer of fascia from the other side. Some of its more posterior fibers blend with the buccopharyngeal fascia. Anterior to the pedicle the fascia becomes separated by areolar tissue so that immediately behind the thyroid isthmus and pyramidal lobe a definite cleavage plane is found.

The suspensory ligaments of the thyroid gland are thickenings of the pretracheal fascia which pass from the inner margins of the gland to the cartilaginous framework. (Fig. 1A.) These two ligaments, right and left, form a sling which anchors the gland to the larynx; they must be severed before the gland can be properly mobilized. In large goiters they increase in size and prevent the thyroid from falling away from the larynx.

The structures which are found between the layers of the pretracheal fascia are the vessels which enter and leave the gland. (Fig. 1A.) The superior thyroid vessels are located between the pretracheal and prethyroid laminae. The inferior thyroid artery emerges from behind the carotid

sheath, penetrates the posterior aspect of the pretracheal fascia and passes medially to the pedicle of the gland where it usually divides into two or more branches. The inferior thyroid veins and the ima vessels are situated inferiorly between the prethyroid and pretracheal laminae. The parathyroids, external and recurrent laryngeal nerves and the thymus are situated in different morphologic planes from the thyroid gland and, therefore, lie outside of the fascial investments which have to do with the gland proper. This latter fact was demonstrated by Weller[4] in as early a stage of development as the 20 mm. embryo. The structure of great surgical importance in the prethyroid lamina is the middle thyroid vein. This vessel, although inconstant, usually leaves the gland about its middle, follows the inferior border of the omohyoid muscle across the carotid artery and ends in the internal jugular vein.

The vertical extent of the pretracheal layer of deep cervical fascia extends from the hyoid bone above to the fibrous pericardium over the great vessels in the superior mediastinum below; it blends with the latter. This layer, therefore, forms a sheet or plate as it passes in front of the larynx and carotid system rather than a circular tubing as is formed by the superficial or investing layer of deep cervical fascia.

Prevertebral Layer. The prevertebral layer of deep cervical fascia is of no practical importance in thyroid surgery. Therefore, it is sufficient to state that it is horizontally placed and is an offshoot from the deep surface of the sternomastoid muscle. It passes behind the carotid system, pharynx and esophagus but in front of the prevertebral muscles and vertebrae. Vertically, it extends from the base of the skull above to the posterior wall of the superior mediastinum below.

SURGICAL CONSIDERATIONS

Proper exposure and mobilization of the gland are the two absolute prerequisites for the completion of a successful thyroidectomy. Therefore, certain steps in the operative procedure must be emphasized.

The sternothyroid muscle is considered the key structure in locating the so-called "prethyroid space." A distinct anatomic interval or plane is present between the sternohyoid and the more deeply placed sternothyroid muscles. After entering this plane the operator either can retract the sternohyoid muscle or sever it transversely at a high level, thus avoiding its nerve supply (ansa hypoglossi). The sternothyroid muscle is then identified, exposed and retracted or transversely severed. As a result of this last maneuver the fascia (prethyroid lamina of pretracheal fascia), which surrounds this muscle and is intimately related to the areolar tissue which forms the sheath of the gland, is incised and the prethyroid space is entered. Although the sheath has been severed and the proper cleavage plane entered, the gland, nevertheless, cannot be mobilized because of the lateral attachment of the pretracheal fascia to the thyroid lobe. It is more accurate to state, therefore, that after severing the sternothyroid muscle and its fascia the surgeon enters the prethyroid space.

Entrance into the post-thyroid space is accomplished by separating the prethyroid fascia from the lateral surface of the lateral thyroid lobe. Since the middle thyroid vein runs in this fascia it becomes a practical maneuver to identify this vessel, sever and ligate it. By so doing, a communication is established between pre- and post-thyroid spaces. (Fig. 2A.) The post-thyroid space having been entered, the gland can be properly mobilized and its posterior attachments by its true pedicle are easily identified.

Poate[5] states that as long as one is within the proper fascial planes and severs the vascular connections of the gland, the important nerves and parathyroids remain uninjured.

Once these maneuvers have been accomplished and the gland properly mobilized, any routine of technic which the surgeon has become accustomed to will suffice. In

the technic described by Warren H. Cole[6] the upper pole is first isolated, clamped and doubly tied. The lobe is then rolled forward and the remaining attachment of the upper pole is clamped and severed. The inferior vascular attachments and ima vessels are ligated and dissection is carried toward the midline exposing a small section of trachea. Routine removal of the gland by clamp and cut method is then instituted.

SUMMARY

1. Numerous dissections performed in both operating room and dissecting room have shown that the idea of a so-called thyroid capsule or sheath which completely surrounds the thyroid gland without any connections is morphologically and surgically incorrect.

2. Two distinct cleavage planes exist which are identified as pre- and post-thyroid spaces.

3. The prethyroid space or plane is entered as soon as the fascia which lines the posterior surface of the sternothyroid muscle and the areolar tissue which forms the thyroid sheath is incised. The latter two usually are intimately related.

4. The post-thyroid space is a triangular interval which is entered when the middle thyroid vein is severed and the lateral attachment of the pretracheal fascia to the lateral border of the thyroid lobe is incised.

5. A thorough understanding of the deep cervical fascia and its simple arrangement into three layers enables one to utilize true fascial planes in thyroid surgery rather than attempting to demonstrate and enter a complete encircling capsule or sheath which does not exist.

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INSTRUMENT FOR PRECISE FORMATION OF THE TUBE GRAFT AND FRENCH FLAP*

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THE French or sliding graft, single or double, and the tube graft are used in the repair of certain skin defects. Illustrated herein are a number of diagrams demonstrating their formation and uses. It will be noted that geometric accuracy prevails throughout and that all parts slide snugly into place. (Fig. 1.)

In actual surgical practice such geometric perfection is difficult to obtain with the single blade due to the inherent elasticity and retractibility of the skin. However, with the aid of this instrument, such correctness can be secured readily. Marking the skin with colored guide lines or scratching the outline of the proposed incisions with a knife is eliminated and the required flaps are far more accurate than any obtained by any previous method. Added to this is the advantage that in those cases in which the flaps must be lengthened at a later stage we have a means available to do so and to be certain that the added skin flaps are of the exact measurements as those done previously. (Figs. 2 and 3.)

Method of Use. The desired knife blades are inserted and the distance between the blades adjusted. The instrument is held by the bars and drawn firmly through the tissues. Using one blade as a fulcrum, a circular incision may be made.

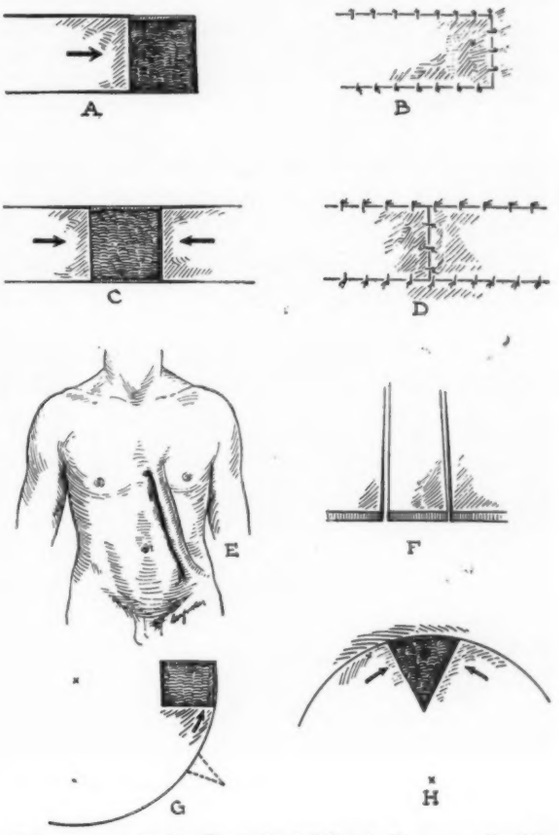

FIG. 1. A, single French (sliding) flap; B, double French flap; E, long tube graft; F, demonstration of accurate surgery possible with double-bladed knife; G and H, demonstration of skin defects closed with circular incisions.

ADVANTAGES AND USES

1. Parallel incisions through the skin can be made in any width for any length.

2. The centimeter scale permits later reproduction of the original pattern if required.

3. The instrument will adjust from 0.5 cm. to 10 cm.

4. For the double French flap, accuracy is assured that both flaps will be of equal width.

5. A geometrically precise tube graft of any size can be made in any part of the body.

6. With one knife blade as a pivot, curved flaps may be formed and circular incisions made.

* From the Department of Plastic Surgery, Jewish Hospital, Brooklyn, N. Y.

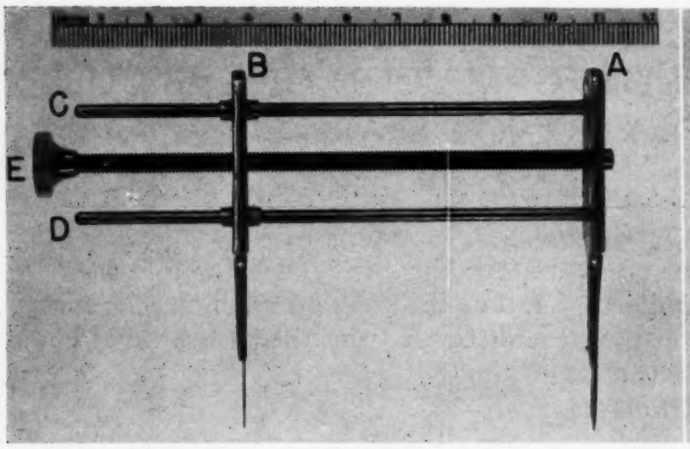

FIG. 2

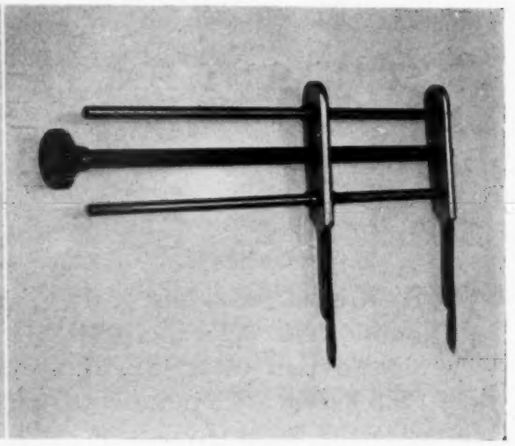

FIG.3

FIG. 2. A and B, knife blades; C, calibrated bar for measuring purposes; D, stabilizing bar; E, curled knob and long screw for adjusting knife blades.
FIG. 3. Angle view to show details of construction.

7. All incisions are made at right angles to the skin. There is no bevelling of the skin edges.

8. The operative procedure is shortened.

SUMMARY

This instrument has been used in several selected cases. It is presented as a useful addition to the armamentarium of the plastic surgeon. It is hoped that it will facilitate procedures hitherto considered difficult for the plastic repair of certain skin defects and the treatment of specific lesions. With precision flaps available, better cosmetic results will be obtained.

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In 1878 the curriculum was extended to two years of nine months each and in 1880 three such years of study became necessary before a candidate could present himself for final examination. In 1890 the compulsory term of study was extended from three years to four. The three years of nine months each had allowed a graded curriculum to be established; the addition of a fourth year permitted further gradation and gave opportunity for the extension of laboratory teaching. The main features of the curriculum in operation since that date have been sequence and concentration in the subjects presented, abundant labora-

tory teaching and a general survey of each branch by means of lectures, recitations and demonstrations. A combined curriculum in letters and medicine was provided in 1890 and graduate courses were offered.

The Medical Library of the University of Michigan now numbers 73,863 volumes. Five hundred thirty-three of the best current medical journals in English, French, German, Italian and Spanish are regularly taken. The Library is essentially one of medical reference and has become a very complete reference library for modern medicine. The volumes contained in it give practically the complete evolution of modern pathology, experimental physiology and pharmacology, bacteriology, serology, immunology, practical hygiene, anatomy and experimental medicine and surgery of the last hundred years. In addition to the volumes contained in this library there is a large amount of medical material available in other departmental libraries and the General Library. Were the entire medical material of all the libraries belonging to the University collected in one library, the medical collection of the University of Michigan would rank in size and importance among the foremost libraries of the United States. As it is at present it holds the rank of the most important reference medical library directly connected with any medical school.

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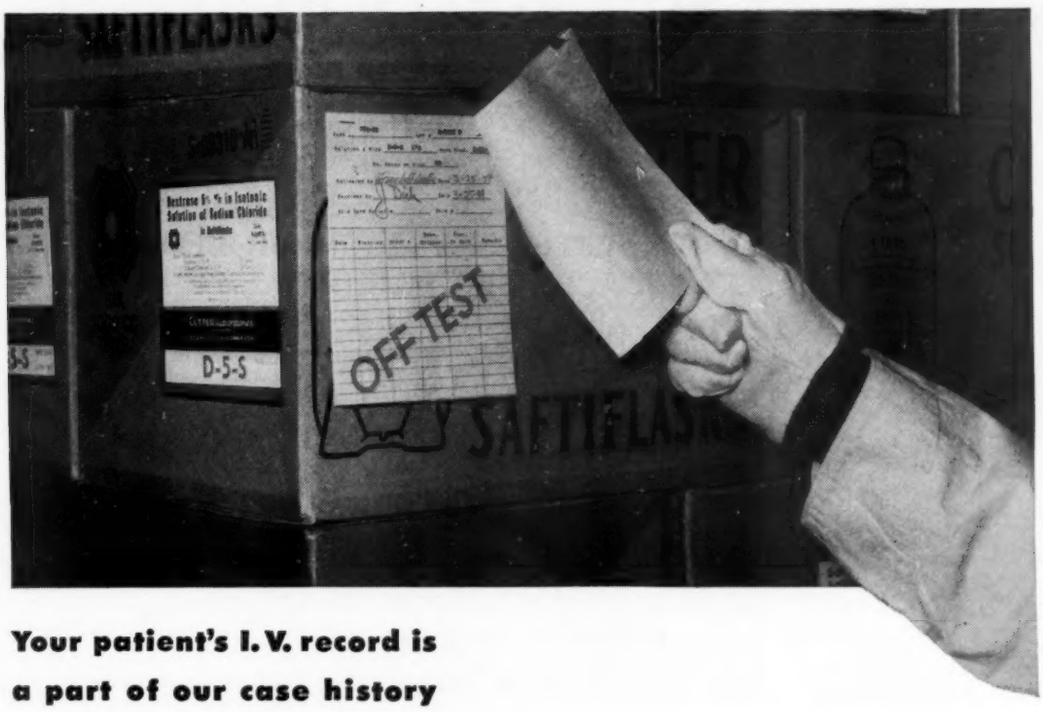

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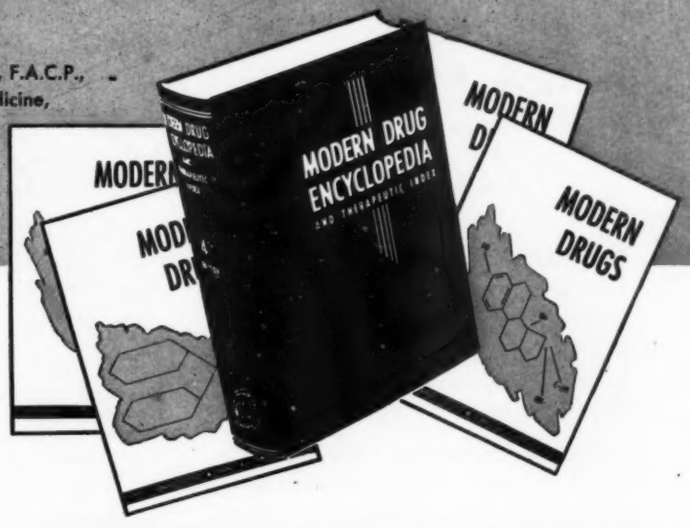

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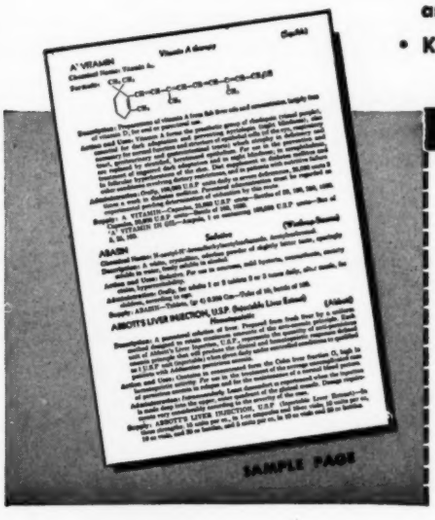

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